THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.—VOL. III.

(*Provisional Title*)

REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

AND

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NOTICE.

I FIND it difficult to express my obligation to my friend, Mr Alexander Agassiz, for the valuable assistance which he has given me in carrying out this undertaking.

Shortly after the return of the CHALLENGER Mr Agassiz came to Scotland, and we went over the enormous collection together, when his remarkable familiarity with invertebrate forms was of the greatest possible service in selecting and separating the different groups, and preparing them for the specialists to whom they were finally to be consigned.

Mr Agassiz afterwards undertook the description of the ECHINOIDEA, in which order his personal acquaintance with all known types, recent and fossil, gives him an advantage as an authority over all his contemporaries: without some such special training, it would have been a matter at least of extreme difficulty to decipher the complex relations of the multitude of singular forms, intermediate between the faunæ of ancient and modern times, which have been brought to light by the Challenger Expedition.

In all cases in which the question of nomenclature has been left entirely to myself, I have, after full consideration, adopted the code approved by Mr Strickland's Committee, and successive Committees of the British Association, and especially that part which inculcates the reference of the name of every *species* to the name of the first post-Linnean describer. My friend and I agree to differ somewhat on these points, and I here take refuge in my former explanation, that in such cases I can act only as Editor.

Several important contributions to the natural history of some of the more obscure groups of marine articulata, have been for some years known from the

pen of Dr P. P. C. Hoek of the University of Leiden. I have to thank Mr Darwin for suggesting to me that I should invite Dr Hoek's kind co-operation in preparing the report upon the PYCNOGONIDA, an aberrant group of Arthropoda to which we had been fortunate enough to add a large number of novel and striking species. Dr Hoek's memoir has proved a valuable addition to the literature of the order, and I am glad to say that Dr Hoek has been induced to continue his labours by monographing the CIRRIPEDIA.

C. WYVILLE THOMSON.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the ECHINOIDEA,[1] dredged by H.M.S. Challenger during the Years 1873-1876. By ALEXANDER AGASSIZ.

INTRODUCTION.

In preparing this Report on the Challenger ECHINOIDEA, I have purposely limited myself to such topics as seemed most germane to the object of the Challenger Expedition, viz., the careful systematic description of the species collected, and a detailed comparison in all directions which promised to shed any light on the characteristics of the Echinid fauna of the depths of the sea.

A careful comparative study of the new species collected by the "Challenger" and by the "Blake," seems to make a short revision of some of the principal lines of affinities of the recent and fossil Echinids desirable; as from our present knowledge of the affinity of the Echinoidea several groups formerly considered somewhat aberrant can now be shown to be closely connected. New and most unexpected systematic views have in many cases been suggested by this comparative study of the striking deep-sea genera. This comparison is the more interesting, as it brings out more prominently than could otherwise have been done the genetic succession which undoubtedly exists between the types still found living at great depths, and other genera characteristic of the Cretaceous and Tertiary periods.

There remains much to be done in the minute anatomy, not only of the new deep-sea types but of the whole group of Echinoidea. We know as yet practically nothing of the histology of the principal families; for this reason I have not attempted a more detailed examination of the Challenger Echinids, interesting and instructive as it undoubtedly would have been, since there existed no terms of comparison in the other groups. To have attempted to carry out such a comparative scheme for the

[1] It has been found impracticable to incorporate in this Report publications on the Echinoidea which have appeared during the winter of 1879-80 and subsequently.

anatomy of the Order would have delayed this Report far beyond the time allotted to me, and it was taken for granted that this part of the subject would have to be undertaken *de novo* for the whole group. The comparisons which have been attempted here are rarely made from the study of monographs alone; they are based on an extensive acquaintance, not only with the recent species but also with the fossil. The number of the latter, although many times greater than that of the recent species, is yet by no means so great[1] as to make an accurate knowledge of all the principal species a difficult task. As it has been my good fortune to examine for myself all but a few of the deep-sea species collected thus far, this Report has been prepared under the best possible circumstances, with the aid of the large collections both of recent and fossil species in the Museum of Comparative Zoölogy at Cambridge, Mass.

Having described the first important collection of deep-sea Echinids made, that of Count Pourtalès, it has been for me a most gratifying task to work up the report of the magnificent collection of the Challenger, and to have the opportunity, thanks to the generous invitation of Sir Wyville Thomson, of going over the whole group of Echinids again with so much new and important material at my command, which could not fail to develop many novel and unexpected problems relating to the past and present history of Sea-urchins.

Classification.

With regard to the general classification of the Echinoidea, the additional light obtained from the deep-sea genera regarding the systematic affinities of many fossil forms would lead us to modify somewhat the systematic arrangements hitherto proposed. I have already given my reasons for not adopting the artificial classification in vogue; the same objections which apply to the system adopted by Wright, apply with equal force to those of de Loriol and of Zittel, wherever they are based upon characters of such uncertain value as the presence or absence of teeth, or the presence or absence of actinal cuts. We, of course, admit the ease of application of these characters as keys for the identification of fossils, and also the difficulty we find in bringing fossil species within the limits of the smaller subdivisions adopted among the recent Echinids, from the impossibility of tracing characters generally imperfectly retained. Several of the sub-families readily recognised among the recent Echinids are not generally adopted by palæontologists, and they have, perhaps, in other directions divided the group into smaller subdivisions, based on structural features which the study of recent types shows to have but little value.

I would in the first place regard the Palæechinoidea as one of the sub-orders of Echinoidea, the others being the Desmosticha, the Clypeastridæ, and the Petalosticha.

[1] According to Zittel the number of fossil species does not exceed 2000.

With regard to the further subdivision of the Palæechinoidea, the subdivision proposed by Zittel into Cystocidaridæ, Bothriocidaridæ, and Perischoechinidæ, seems to represent well our present knowledge of the group. The further subdivision, however, of the Perischoechinidæ into Lepidocentridæ, Melonitidæ and Archæocidaridæ seems somewhat doubtful. The Archæocidaridæ, at any rate, and the Palæechinidæ (M'Coy) appear to form most natural subdivisions. The Melonitidæ and Lepidocentridæ hardly seem to be sufficiently distinct to be separated into different groups; and the Palæechinoidea, as a whole, can hardly be contrasted, after what has been said of the structure of the test, to all the remaining types of Echinoidea, as is proposed by Zittel and other palæontologists.

Both in the Desmosticha and in the Petalosticha the difficulties of properly combining the subdivisions adopted on the one side by palæontologists, and on the other by those who have mainly studied recent Echinids, are very great.

The groups recognised by both, and concerning which there seems to be but little question, are the Cidaridæ, the Salenidæ, and the Echinothuridæ. The other subdivisions, the Arbaciadæ, the Diadematidæ, the Echinometradæ, and the Echinidæ, which are in addition recognised by writers on recent Echinids, are by palæontologists limited to the Diadematidæ and the Echinidæ. This limitation seems scarcely warranted by our knowledge of the recent Echinids, while on the other hand our information regarding the structure of the apical and of the actinal systems of the greater number of the fossil genera is not accurate enough to enable us to place many of them with any certainty into the families adopted by those who have limited their studies to recent species. But such groups as the Arbaciadæ and Echinometradæ, if not of the same systematic value as the subdivisions Cidaridæ, Diadematidæ, and Echinidæ, are certainly as important as the Temnopleuridæ and Triplechinidæ.

As regards the Clypeastroids, the agreement is quite close. We have only to add to the families recognised by writers on recent species the Galeritidæ and the Conoclypeidæ, which are represented by a single recent species only in each group, leaving the following recognised among the Clypeastroids—the Galeritidæ, the Conoclypeidæ, the Euclypeastridæ, and the Scutellidæ. Among the Petalosticha the larger subdivisions of the recent species are the Cassidulidæ, still further subdivided into the Echinoneidæ and the Nucleolidæ; and the Spatangidæ, with the Ananchytidæ, the Spatangina, the Leskiadæ, and the Brissina. The separation of the Holasteridæ, as contrasting with the Spatangidæ as a distinct family by some palæontologists, seems hardly justified from our present standpoint, and it certainly seems more natural to consider the Dysasteridæ and the Ananchytidæ as sub-families of the Spatangidæ; the structure of the Pourtalesiæ and of other recent Ananchytidæ seeming to render a separation into Holasteridæ and Spatangidæ unadvisable.

Determination of the Axis of the Echinoidea.

Of the attempts to define from the position of the antero-posterior axis of the Echinids the relative position of the different zones, by far the most ingenious is that of Lovén.[1] Adopting the position of the antero-posterior axis of Echinids first defined by Desor, and subsequently fully elaborated by Cotteau,[2] he has proposed a most admirable notation to denote the several ambulacral and interambulacral areas, which simplifies to a remarkable degree the comparison of the various types, by making it possible to number conveniently the plates of which these areas are composed, and thus readily to call attention to any modifications they may undergo. While, however, we shall adopt generally the nomenclature of Lovén, we wish also to be understood as not agreeing with his conclusions regarding the mode of ascertaining the position of the theoretical axis which he has adopted.

It will be necessary to give a short résumé of his method of comparison of the corresponding ambulacral and interambulacral areas. If we place any recent Spatangoid with the actinal opening upwards and the odd ambulacrum in the line dividing the petaloid ambulacra symmetrically, and call the left posterior ambulacrum I.; the left of the anterior pair II., the odd ambulacrum III., the right anterior IV., and the right posterior V.,—if we then call the first plates of these ambulacra respectively *a*, *b*, in the order of their sequence from right to left, we shall, according to him, have the following formula to denote the order of identical ambulacral plates; the larger plates composed of two primary plates, the sutures of which have disappeared, with two ambulacral pores, are I.*a*, II.*a*, III.*b*, IV.*a*, V.*b*, while the corresponding plates of the ambulacra belonging to the formula I.*b*, II.*b*, III.*a*, IV.*b*, V.*a*, are smaller and only perforated for a single pore (tentacle).

By going through the whole group of Echinids, exclusive of the Perischoechinidæ, Lovén finds that by placing the test in the position indicated, the above formula will always hold good; that is by placing the test in such a way that the madreporic body is on the right of the odd ambulacrum, when placed with the actinostome downward. Calling, again, the interambulacral spaces corresponding to them 1, 2, 3, 4, 5, he finds that the large and small interambulacral plates in the Echinoidea (exclusive of the Clypeastroids and Petalosticha) are arranged round the actinal opening according to the formula, 1*a*, 2*a*, 3*b*, 4*a*, 5*a* for the small plates, and 1*b*, 2*b*, 3*a*, 4*b*, 5*b* for the large plates. Now, Lovén gives us to understand that this denotes some special quality in the areas I. to V. and 1 to 5, as he has numbered them. But this it seems to me is not the fact, as we get an identical formula whether we number each of the five ambulacra and interambulacra in succession I. to V. or 1 to 5. The result will always be the same, as will easily be seen

[1] S. Lovén, Études sur les Echinoïdées, Kongl. Svensk. Vetensk. Akad. Handl., xi., No. 7, 1874.

[2] G. Cotteau, Note sur la famille des Salénides, Bull. Soc. Géol. de France, tom. xviii. p. 614, 1861.

on comparing, *mutatis mutandis*, the following table, which shows the same agreement pointed out by Lovén whichever ambulacrum we start with. These formulæ are all made from Lovén's own figures.

I. Lovén's formula—

$$\begin{cases} \text{I.}a,\ \text{II.}a,\ \text{III.}b,\ \text{IV.}a,\ \text{V.}b, \text{ large plates,} \\ \text{I.}b,\ \text{II.}b,\ \text{III.}a,\ \text{IV.}b,\ \text{V.}a, \text{ small plates.} \end{cases}$$

II. Taking the ambulacrum he has called II. as I., we get both for the Spatangoids and Echinids—

$$\begin{cases} \text{I.}a,\ \text{II.}b,\ \text{III.}a,\ \text{IV.}b,\ \text{V.}a, \text{ large plates,} \\ \text{I.}b,\ \text{II.}a,\ \text{III.}b,\ \text{IV.}a,\ \text{V.}b, \text{ small plates.} \end{cases}$$

If we take III. as I. the formula is—

$$\begin{cases} \text{I.}b,\ \text{II.}a,\ \text{III.}b,\ \text{IV.}a,\ \text{V.}a, \text{ large plates,} \\ \text{I.}a,\ \text{II.}b,\ \text{III.}a,\ \text{IV.}b,\ \text{V.}b, \text{ small plates.} \end{cases}$$

If we take IV. as I.—

$$\begin{cases} \text{I.}a,\ \text{II.}b,\ \text{III.}a,\ \text{IV.}a,\ \text{V.}b, \text{ large plates,} \\ \text{I.}b,\ \text{II.}a,\ \text{III.}b,\ \text{IV.}b,\ \text{V.}a, \text{ small plates.} \end{cases}$$

If we take V. as I.—

$$\begin{cases} \text{I.}b,\ \text{II.}a,\ \text{III.}a,\ \text{IV.}b.\ \text{V.}a, \text{ large plates,} \\ \text{I.}a,\ \text{II.}b,\ \text{III.}b,\ \text{IV.}a,\ \text{V.}b, \text{ small plates.} \end{cases}$$

Showing most conclusively that any one of the ambulacra taken as I. will give a corresponding formula for all the Echinids, and that the I. chosen by Lovén with reference to the madreporic body has not the taxonomic value he has suggested, as far as an antero-posterior axis is concerned, any one of the other ambulacra giving precisely the same relation. I do not wish by this to deny the importance of the relations between the ambulacral plates established by Lovén. I only wish to show their general character, and deprive them of the geometric value he has assigned to them. The formulæ for the interambulacral plates are similarly universal.

Taking 1 as adopted by Lovén—

Lovén's formula for large plates is 1*b*, 2*b*, 3*a*, 4*b*, 5*b*,
„ „ small „ 1*a*, 2*a*, 3*b*, 4*a*, 5*a*.

Taking 2 as 1 we get—

for large plates, 1*b*, 2*a*, 3*b*, 4*b*, 5*b*,
„ small „ 1*a*, 2*b*, 3*a*, 4*a*, 5*a*.

And so on, the corresponding formulæ finding their universal application to all the interambulacra taken in turn, and that in addition no one has any pre-eminence above any

other. It seems to me that Lovén's attempt to fix the axis of the Echinoidea by means of the position of the plates round the actinostome must of necessity fail. It is at the actinostome that all the accumulated disturbances during the whole growth of the Sea-urchin concentrate. It is there that constant resorption and crowding is taking place, and while acknowledging the infinite skill with which Lovén has attacked the subject, many of his conclusions are not of as general application as would at first sight appear. If we examine in the simplest Echinids (the Cidaridæ and Salenidæ) the plates as they make their appearance around the apical system, we shall find no such general formula as has been so ingeniously framed for the actinostome. Taking, for instance, the pores at the actinostome according to Lovén's formula in a species of *Porocidaris* we get the usual formula I.*a*, II.*a*, III.*b*, IV.*a*, V.*b*, and we have for the interambulacral system a regular alternation of large and small plates, while at the abactinal system where the plates appear first we get—

1*a*, 2*b*, 3*b*, 4*a*, 5*a*, for the small plates ; and
1*b*, 2*a*, 3*a*, 4*b*, 5*b*, „ large „

In a younger specimen, on the other hand, the interambulacral plates alternate regularly, and we get—

1*b*, 2*b*, 3*b*, 4*b*, 5*b*, for the small plates,
1*a*, 2*a*, 3*a*, 4*a*, 5*a*, „ large „

Their order and formula depending upon the rate of growth of the smaller interambulacral plates, which is evidently a rate quite independent in the different interambulacra, and the formula will of course depend upon the particular stage of growth at which the urchin is examined. In two species of *Salenia* we find the same difficulty, Lovén's formula holding good for the actinostome ; as regards the ambulacra, we have the following formulæ different for the interambulacral plates when we take them as they appear round the apical system—

1*b*, 2*b*, 3*a*, 4*a*, 5*b*, for the small plates,
1*a*, 2*a*, 3*b*, 4*b*, 5*a*, „ large „

while in another stage of the same species we have the large and small plates regularly alternating—

1*a*, 2*a*, 3*a*, 4*a*, 5*a*, for the small plates; and
1*b*, 2*b*, 3*b*, 4*b*, 5*b*, „ large „

The same I found to be the case at the apex of *Salenia varispina*. It seems to me that those who have attempted to define the antero-posterior axis of the Echinids have failed from their not taking into account the embryological data. These, it is true, are scanty, yet they are sufficient to settle the question of the all importance of the madreporic body,

both physiologically and morphologically; and further, they have failed from not sufficiently taking into account the dorso-central system of Clypeastroids, and in attempting to pass at once from the Goniocidaridæ (the regular Echinids) to the Spatangoids (Petalosticha) have left out an important term of comparison.

From embryological data[1] the madreporic body indicates in Echinids, Starfishes and Ophiurans the line along which the suture of the open spiral of the young Echinoderm has taken place. It is the only body in the regular Echinoidea which can denote any axis, and from the mode of development of the interambulacral system, after the ambulacral, merely indicates that the two ambulacra adjoining it are developed at the opposite ends of the open spiral once forming the young Echinoderm; so that any starting-point we wish to take, in making out formulæ for the arrangement of the plates, ought to be chosen with reference to the position of the madreporic tubercle, and should be either the one to the right or to the left of it, that is, either of the ambulacra which Lovén has numbered III. and II. They mean something, and have a definite value, which the others have not; and the fact that the right anterior interambulacrum frequently contains the madreporic body in Spatangoids is no proof that the interambulacral area of regular Echinids which contains it is the right anterior interambulacrum, as has been supposed by the majority of writers on the Echinoidea.

Nothing in the position of the anus can help us to determine in the Desmosticha which is the odd interambulacrum except the tendency we see in some genera of the anal system to approach that interambulacrum; since while within the genital ring nothing in its position can guide us to any axis corresponding to that of other sub-orders where additional structural features leave us no doubt of its position. I have shown in the Revision of the Echini that the general trend of the alimentary canal and its windings are of no assistance in this matter, and that the position of the anus in different genera of Echinometradæ shows that, in the regular Echinoidea at any rate, it cannot be used to determine any axis; while, on the contrary, the position of the anus in the Clypeastroids and Petalosticha, and the frequent specialisation of one of the ambulacra in the latter, gives us a ready clue to fix the axis of these groups.

The youngest Echinids I have examined, immediately on the resorption of the Pluteus (Mem. Am. Acad., 1864), show plainly why we should not have the relations between the different ambulacral and interambulacral plates discovered by Lovén limited to a single one of the zones. The first trace of the ambulacral system in each ambulacrum consists of five loops becoming subsequently five tentacles, which are absolutely similar. These large embryonic tentacles are not, as Lovén supposes, temporary, as can be readily seen on examining the figures of the paper referred to above, which shows the gradual increase in number of the original tentacles, the mode of formation of

[1] See A. Agassiz, Embryology of Echinoderms, Mem. Am. Acad., 1864; A. Agassiz, Embryology of the Starfish, 1864.

additional ones, as new loops immediately below the odd terminal tentacle, being identical with that in the Starfish. Several recent writers on Echinoderms deny the existence of this odd terminal tentacle, the homologue of the odd ocular tentacle of the Starfish (see Embryol. Starfish, pl. viii.). I would refer them to the figures of young *Arbacia* in the Revision of the Echini, p. 735, and of young Echinids (*Strongylocentrotus dröbachiensis*) in the Mem. Am. Acad., 1864, for figures of this terminal tentacle, and to the Revision of the Echini, pl. x. 1872, part 3, and to the figures of young *Goniocidaris canaliculata* in this memoir (Pl. II.). There is nothing to show that the interambulacral zones in the earliest stages at which they can be detected, do not consist at the beginning of several plates, more or less rudimentary, all appearing at the same time. It seems to me more natural to suppose that in the Clypeastroids we have the madreporic body in the neutral position, indicating the mode in which the madreporite passed from an unstable condition, owing to the presence of an apical anal system, to a stable one, due to the withdrawal of the anal system to one of the interambulacral areas, which then became the principal guide in fixing the position of an antero-posterior axis until the madreporic body again had a tendency to encroach upon certain parts of the genital system in the Petalosticha, when the position of the axis was again defined by the position of the anus and of the simple ambulacrum.

Far too much weight has been given to the order of appearance of the plates of the ambulacral and interambulacral areas in this discussion. The coronal plates, as is well shown in young Echinids, while divided into ambulacral and interambulacral areas, do not, as far as we have been able to trace their appearance, develop in such a regular and fixed manner as to enable us to determine the axis of the Echinids from the order of their origin.

Comparison of the Coronal Plates of the Test in Different Families.

Among the Clypeastroids, it is only in the younger stages that the interambulacral plates are connected at the actinostome as in Spatangoids. The actinal ambulacral plates soon increase so fast in width as to drive them apart, and in the older stages of some genera[1] the second row of ambulacral plates forms a continuous ring round the actinostome, while in others[2] the odd posterior interambulacrum still extends connectedly to the actinostome, as it is in the adult of *Echinocyamus* and *Laganum*, and in others forming in part a trivium and a bivium as in *Rotula*, while in *Echinarachnius* it is the odd posterior interambulacrum of which the actinal plates become first disconnected.

Echinoneus comes in at once as a marked exception to Lovén's theory, as well as all the Clypeastroids, where in no stage do we find that the actinal plates have the characters upon which Lovén's theory of an axis is based.

Lovén has already called attention to the greater affinity existing between the

[1] *Encope, Clypeaster, Arachnoides.*

[2] *Mellita.*

Collyritidæ and the Cassidulidæ, and has shown that the separation of the apical system into a bivium and a trivium, which at first sight appears so important, is not accompanied by corresponding changes in other structural features of the test. On the contrary, these groups agree in having comparatively simple ambulacra, without great differences in the size of the plates of the interambulacra, and are thus more closely related still to the Echinoneidæ of the secondary period, of which they appear to be at the present day the representatives; and it is by the changes taking place in the odd posterior interambulacrum that this group approaches at last more closely the recent Spatangoids.

Lovén is disposed to consider the second actinal plate of the right posterior interambulacral plates as made up of the plates 2:2. I am more inclined to consider the first and second plate as the breaking up of the first actinal plate into two parts, as a similar splitting up of the actinal plates frequently occurs in the very elongate plates of the actinal plastron of other Spatangoids. From the very fact that in such closely allied genera as *Hemiaster* and *Faorina* the second plate is, according to Lovén himself, made up in the one case of 2:2, and in the other 2:3, I am the more inclined to look upon this as a mechanical result due to the irregular termination of the median interambulacral line of the posterior pair of interambulacra compared to the anterior pair, and thus far nothing has been traced in the growth of the young Spatangoids to sustain the view taken by Lovén. It seems to me, on the contrary, that it is in the modifications of the odd posterior interambulacral area that we must look for the passage between the two groups of Spatangoids which Lovén has followed. These can still be traced, but very imperfectly, in the other lateral interambulacra which are not as deeply affected by the change of form as the odd posterior interambulacral area. I am rather inclined to look upon this heteronomy of the right posterior interambulacrum, which Lovén has noticed, as the last trace of the structural affinity of the Clypeastroids to the Spatangoids, the more so from the existence of such a genus as *Palæostoma*, in which we find in all the paired ambulacra two single actinal plates in succession, the last trace of the zigzag arrangement of the actinal plates of the paired interambulacral spaces. If, on the other hand, with this explanation of the modifications of the paired lateral interambulacra, we trace the changes which the odd interambulacrum undergoes, we can trace these directly either to the more or less central position of the actinostome or to the elongation of the test which greatly modifies the composition of the plates of the actinal plastron, and this, it seems to me, is a more natural explanation of the heteronomy existing in the Spatangoids than the ingenious homologies of the successive soldering of the plates 2:2 or 2:3 advanced by Lovén.

Older writers on the Echinoidea have already insisted on the similarity of the plates composing the different ambulacral and interambulacral areas in the regular Echinids, and their difference in the so-called irregular Echinids. This division, which at first sight seems so fundamental, is most artificial; and when we carefully analyse such groups as the

Discoideæ and the Clypeastroids, and compare them to the true Spatangoids, it seems impossible any longer to lay stress upon the characters which have mainly led palæontologists to adopt these two great primary divisions. As has already been pointed out by Lovén, the variations introduced are greatest on the actinal surface, and greatest in the posterior region of the test. In the Echinoidea the first trace of such a want of symmetry on the actinal side is found in the Echinometradæ, while on the abactinal surface the position of the anal plate in certain genera of Echinids, especially of the anal plate in the Salenidæ, indicates very early the tendency to an asymmetrical development which culminates in the Spatangoids of the present day. The next stage in this asymmetrical development is due to the exclusion of the anal system from the apical system, and the corresponding marked distinction at once existing among the Discoideæ in the arrangement of the plates of the odd posterior interambulacral area, and the compact apical system thus formed, which becomes the basis of the subsequent modifications it undergoes on the one side in the Clypeastroids, from the soldering of the plates by the spreading of the madreporic body, and the exclusion of the genital openings from the apical system, and their appearance in the apical part of the interambulacral region; and on the other either into the compact apical system of the recent Spatangoids or the disjunct apical system of the Collyritidæ.

In the Clypeastroids the asymmetry of the plates is almost entirely limited to the posterior interambulacral area, and the further extensive development of the coronal plates of the test which is limited to the whole of the actinal surface, and not to a single area as in the Spatangoids proper.

Passing from the Discoideæ to the Cassidulidæ we find there a further modification of the actinal surface from that of the former group extending to the actinostomic plates which still exists at the present time; and the first trace also of a more distinct petaloid system than we find among the Collyritidæ. The asymmetry of this group is limited to the actinal surface, and to the odd interambulacral area. If we further examine the older Spatangoids we find that in all the more globular genera, such as *Hemiaster*, there is a marked uniformity in the size and number of the coronal plates; though by no means so great as that in the Collyritidæ or such genera as *Galerites* and the like, of which the deep-sea genera belonging to the Pourtalesiæ, such as *Cystechinus* and similar forms, may be considered as the representatives; and thus we little by little pass from genera in which the actinal plastron differs only slightly from the other interambulacra, *Cassidulus*, *Holaster*, *Pourtalesia*, *Genicopatagus*, and *Hemiaster* to the genera with a more marked actinal plastron, such as *Palæostoma*, *Agassizia*, and *Spatangus*, and finally to *Meoma*, *Brissopsis*, *Echinocardium*, *Brissus*, &c. It by no means follows, however, that the specialisation of the ambulacral petals has kept pace with this elongation of the actinal plastron, as can readily be noticed on comparing such widely-differing genera as *Echinocardium*, *Spatangus* and *Schizaster*, which are all characterised by this highly-developed

actinal plastron of which, perhaps, the most embryonic type is that of the Ananchytidæ, in which the plates comprising it are more or less hexagonal or pointed, extending beyond the median interambulacral line.

Very important changes also take place in the actinostomic plate of the odd interambulacral area, which becomes, as is well known, the lip terminating the more or less keeled actinal plastron, which thus becomes a kind of plough to shovel into the actinostome the sand or mud in which such forms live. It is upon this plastron also that we find developed the flat paddle-shaped spines so characteristic of the Spatangoids of the present day. This lip is but little prominent in the older Spatangoids, it has no prominence in the Collyritidæ; in fact, we might call that form of actinostome the palæostome. It is still represented at the present day in *Palæostoma*, and the young of all Spatangoids have such an actinostome of a more or less pentagonal form. In the Clypeastridæ, the Galeritidæ, and the Cassidulidæ we have modifications of the actinostome which subserve more or less the same purpose as the strongly labiate actinostome of the majority of recent Spatangoids; but in these types the actinostomic plate of the odd interambulacrum is not specialised, and we can trace its growth very satisfactorily from the Collyritidæ to the Hemiasteridæ, the Spatangidæ, and the Schizasteridæ of the present day, while we find in the Pourtalesiæ and in *Palæostoma* the persistence of the ancient actinostome, combined in the latter with many recent structural features of the Spatangina.

I have already, while speaking of the Pourtalesiæ, called attention to the mode of development of the anal snout of that group from the episternum of the Spatangoids proper.

Anal System.

In the structure of the plates of the anal system we have from embryological data a clear explanation of the function of the anal plate of the *Saleniæ*. This anal plate was, if we can trust the figures of Schmidt, perhaps already developed even in *Bothriocidaris*, and may have existed in other Palæechinidæ, though it may be difficult in the plates covering the anal system of that group so easily to recognise the original anal plate as we can do in many of the recent Triplechinidæ. The figures of Bailey, and of Meek and Worthen, and a specimen of *Lepidesthes* which I have had occasion to examine, would seem to indicate a splitting up of the central plate into a great many smaller plates, more according to the mode in which it takes place in the Arbaciadæ. The excentric position of the anal opening is also clearly shown to be due merely to the development of new plates along one edge, while where the anal opening is formed symmetrically, we have the anal system as in the Arbaciadæ covered by a few large plates.

The transition of the opening of the anal system to the area within the genital ring, and into the odd interambulacral region, as we find it in all Spatangoids, is not, however,

a change of which we can follow the traces in successive geological periods. The position of this opening is a very variable one, and in the life history of a young Sea-urchin it passes from its original place near the actinostome to one within the apical system, plainly showing that during the earliest stages of growth the position of the external opening of the extremity of the alimentary canal is still undetermined, and that we must not attempt to find in the geological sequence any explanation of this transfer any more than the position of the genital opening within or without the genital plates gives us in the history of the growth of the Clypeastroids any clue to its causes.

The position of the anal opening among the Spatangoids is in reality, as has been shown by Lovén, not an advance, but the retaining of a structural feature once uniform among the earliest Echinoderms, and which we find in all the Palæozoic Crinoids, but which may nevertheless have very gradually been developed again during the geological succession, as there are indications already in the Palæechinidæ of such an excentric position of the anal system. And we find, as has been so well shown by Lovén, in the older Echinoidea a marked encroachment of the anal system upon one of the genital plates, which culminates in some species of *Acrosalenia;* and we may consider this as the last trace, perhaps, in the regular Echinids of the excentric position of the anal system without the apical system, the last trace of a condition of things which was more universal and which tends gradually to be constituted as we find it in the Echinids of the present day. While in the groups in which we find a retrogression, as it were, to the ancient condition of things we find it accompanied by a renewal of the functions of the genital plates, and at the same time by the encroachment of the madreporic body upon the other plates, thus often occupying the whole central part of the apical system, and thus again giving us an explanation of the many genital plates which may be occupied by parts of the madreporite in the earliest Palæechinidæ, as we find it in several of the genera figured by Bailey, Worthen, and others. And we can gradually trace both in the Echinoneidæ and in the Cassidulidæ the regular geological succession existing between the genera with the anal opening close to the apical system, and those in which at the present day it is found on the actinal surface, and we see that while the circular or globular species are the more ancient, they are little by little replaced by species in which the longitudinal axis becomes more marked, the anal system at the same time gradually passing from the apex towards the ambitus and finally to the actinal side. This forms a striking contrast to the embryological fact that in young Clypeastroids the anal opening is at first always on the abactinal side and gradually finds its way to the actinal surface ; which does not seem to accord well with the view that this tranposition of the anal opening is of a retrogressive character.

The changes the apical system goes through the moment it has become independent of the anal system are very important, and are connected also with other modifications in the plates of the test which radically affect its whole appearance.

The genital plates and the ocular plates, as well as the madreporic body, make the numerous combinations which have been so well traced by Lovén, and which culminate on the one side in such a compact apical system occupied mainly by the madreporic body, as we have it in the Clypeastroids, in which the genital openings in some cases no longer retain a definite position in distinct plates, but may open anywhere in the interambulacral spaces; a state of things whose possibility is already foreshadowed in the genera belonging to types early developed, such as *Cidaris* and the Echinothuridæ. On the other side they culminate in the great specialisation of the ocular and genital plates and their disturbance by the interambulacral plates, encroaching between them, and little by little forming an excessive separation of the ambulacra into a bivium and a trivium, until little by little it becomes again quite compact owing to the more equal development of the coronal plates near the apical system. As Lovén has well shown in the older Echinids (*Cidaris* and *Salenia*), we find all the proof we need of the crinoidial character of the apical system of the Echinidæ; the calyx being more and more unimportant, though it always reveals its typical features.

In the Clypeastroids the calyx, though reduced again to its lowest limits, that is, completely confused, still retains a few traces of its originally crinoid character, and in the earliest appearance of the Spatangoid calyx we have introduced the embryonic element of the structure of the calyx, which we find in late types of the present day, and which recalls to us an arrangement of the plates of the calyx found in the Starfishes only. The excessive splitting of the arms of an Ophiuran bring the abactinal madreporite to a position adjoining the actinal opening.

Fascioles.

Fascioles as such are recognised only among the Spatangoids, but it is very probable that such striking accumulations of miliary tubercles as we find on the edge of some of the *Phormosomas* must be regarded as the first trace of fascioles, which we would thus be led to consider as accumulations of miliary tubercles along certain lines, as we find them in some genera of Spatangoids where their course is not well defined, until at last they assume the fixity and clear definition which we consider so characteristic of our Spatangoids of the present day. As far as my observations go they do not entirely agree with those of Lovén regarding the fixity of their position and the identity of their course in older and younger specimens. Certainly, from what we have seen in the young of *Hemiaster cavernosus*, both the course and position of the peripetalous fasciole is widely different in the older and younger stages. In the one case the fasciole encloses the anal system, in the other it is placed outside it. I have also shown the presence of such rudimentary fascioles in Starfishes,[1] so that fascioles are not confined to Echinids.

[1] Alex. Agassiz, N. Am., Starfish, Cont. Nat. Hist. U. S., vol. v.

We have as yet but few data regarding the development of the fascioles. As far as the palæontological development is concerned, we find that the earliest Spatangoids, like the Dysasteridæ, have no fascioles. In the Cretaceous period we have at first Spatangoids either with a peripetalous or with a sub-anal fasciole; then we have Spatangoids with both; and finally Spatangoids in which the two are connected by a lateral branch, or in which the branch may form an independent fasciole. We find in Adètes Spatangoids, and in those Spatangoids which have no peripetalous fasciole, that the passage from the petaloid to the apetaloid part of the ambulacra is quite gradual, and that in the older genera the plates of the ambulacra are of comparatively uniform size from the apex to the actinostome, while in those genera in which the peripetalous fasciole exists we find a marked contrast between the infrapetalous plates and the following ones; and, owing to the crowding of the additional plates of the petals within this sharply-marked line, we find that the Spatangoids with peripetalous fascioles also have more markedly petaloid ambulacra. It is also within the areas of these fascioles that the ambulacral suckers attain a great development as in *Brissopsis*, in *Aërope*, in *Aceste*, in *Schizaster*, and in the area of the sub-anal fasciole within which the ambulacral pores often take a very regular arrangement forming a sort of shield edged by the fascioles. As Lovén has already suggested, everything we know of the appearance of the anal fasciole seems to show that the anal, lateral, and marginal fascioles are only modifications of the sub-anal fasciole and of its branches, and that the sub-anal fasciole itself may even have originated as a loop of the peripetalous fasciole, although at present the palæontological evidence renders it somewhat doubtful whether the sub-anal and peripetalous fascioles have not originated independently. The internal fasciole I look upon as being an embryonic peripetalous fasciole.[1] There is nothing in the development of the Pluteus to show that the vibratile cords forming such characteristic fascioles in the larvæ of Echinoderms have any relation whatever with the fascioles of the full-grown Sea-urchin; yet every writer who has treated the subject of fascioles invariably goes out of his way to make a comparison between the fascioles and the vibratile cords of the Pluteus; as the fascioles are developed on plates which, as a rule, have not yet appeared during the existence of the vibratile cords, it seems difficult to trace the connection between the two in subsequent stages of growth.

Acanthology.

In an exceedingly interesting paper[2] on the Acanthology of the Desmosticha, Mr Mackintosh has proposed a classification of the spines of the Desmosticha which, as far as his sub-series are concerned, agrees well with the affinities of the families of the group as generally adopted. The primary series do not present, it seems to me, the

[1] See remarks on *Aceste* and *Aërope*.

[2] H. W. Mackintosh, On the Acanthology of the Desmosticha, Trans. Roy. Irish Acad., vol. xxvi., 1878.

structural importance assigned to them by Mr Mackintosh, and when we come to include within his classification the spines of the Spatangoids and Clypeastroids, according to the structural features he has employed to separate his principal series, we should be compelled to unite into one series groups which have no systematic affinity and are zoologically widely separated. The mere fact that the spines of the Diadematidæ are hollow does not seem a sufficient reason for contrasting them to the spines of all the other Desmosticha. I should be more inclined to consider the spines of the Diadematidæ (adopting the nomenclature of Mackintosh) as monocyclic Acanthosphenota, with a more or less hollow interior. An excellent example of the type showing affinities to the Diadematidæ and to the Echinidæ is *Pseudoboletia*; in one section (Pl. XXXVIII. fig. 3) we have the hollow spine as in Diadematidæ, in the other (Pl. XXXIX. fig. 11) the central portion of the shaft is completely occupied by reticulations as in the Echinidæ.

From the examination of the few young spines of Echinids which have been figured thus far either by Müller[1] or by myself,[2] there does not seem to be in the early stages very great differences in the structure of the spines. The young spines are in all cases polygonal, made up of rectangular meshes placed in regular stories one above the other; the upper set of meshes open, while the outer beams send off into the interior smaller rods, the first rudiments of the second or third row of wedges of the polycyclic spines or merely lateral offshoots connecting the large calcareous wedges, the original beams forming the rectangular meshes of the young Sea-urchin. There is no difference in the typical structure of the spine of the young of *Cidaris*, *Echinus*, *Strongylocentrotus*, *Arbacia*, *Echinocyamus*, or *Schizaster*, the genera of which the young spines have thus far been figured.

The modifications which eventually give to the spines their final characteristics are all derived from the changes undergone by this single primitive fenestrate type, and are not features which are found developed early in the plutean stage, or based upon radically different types of structure. The very fact that we have among the Echinids the anomalies to which Mackintosh refers, shows us plainly that the derivation from the original embryonic type has not gone on during growth equally in all the genera of the same family, some of the genera retaining a much more embryonic condition than others. By embryonic, I mean the simple fenestrate structure of the spines such as still exists among some of the Clypeastroids and Spatangoids, in which the reticulation does not extend towards the central part of the shafts, or in the simpler monocyclic types of such genera as *Astropyga* and the Salmacidæ. It is among the Desmosticha, belonging to the Cidaridæ, the Salenidæ, the Diadematidæ, and the Echinidæ, among the oldest genera,

[1] J. Müller, Ueber die Larven u. Metamorphosen der Ophiuren u. Seeigel, Abhand. Berlin Akad., 1848–1855, Abhandlungen, i., iv., vi., vii.

[2] A. Agassiz, Embryology of Echinoderms, Mem. Am. Acad., 1864; The Homologies of Pedicellariæ, Am. Naturalist, 1873.

that we find the greatest divergence from the normal structure of the Sea-urchin spine, while it is remarkable that among more recent genera such as the Spatangoids, and especially the Clypeastroids, we find the simplest types of spines more nearly approaching the spines characteristic of all the young Echinids of the present day. So that we may be said to find at one extremity of the series spines with a complicated structure such as that of the spines of the Cidaridæ, and at the other the simple spines of the Clypeastroids and Spatangoids.

Among the Cidaridæ we do not find either in the new species of *Goniocidaris* or in *Porocidaris* any important points of structure not previously noticed. *Goniocidaris florigera* (Pl. XXXVIII. fig. 11) presents the characteristic *Cidaris* features of an outer crust with a reticulation becoming gradually finer towards the central portion of the shaft occupied by the "pith" (Pl. XXXVIII. fig. 11*a*). Such is also the general structure of the spines of *Porocidaris* (*P. elegans*) (Pl. XXXVIII. figs. 12–16); the reticulation extending from the crust towards the centre is somewhat coarser than in *Goniocidaris*, and the central space occupied by the irregular reticulation of the pith is comparatively greater. In the sections of one of the large elliptical spines the crust is comparatively thin, and four or five of the outer lines of reticulation occupy the space next to the crust, the rest of the central space being filled with the pith (Pl. XXXVIII. fig. 15). In *Salenia* (*Salenia hastigera*) (Pl. XXXVIII. fig. 10) we find an outer crust as in the Cidaridæ, and the same coarse reticulation of the shaft towards the centre which we find in *Porocidaris;* the central pith is quite limited in extent.

In *Cœlopleurus* we have, as in the Cidaridæ, a great development of the close inner reticulation of the shaft (Pl. XXXVIII. fig. 7) with a ring of large foramina round the central pith (see also section of spine of *Cœlopleurus floridanus*, Revis. Ech., pl. ii.[c] fig. 15) with an outer crust much as in the Cidaridæ and Salenidæ; this is the structure of the large curved primary spines. In smaller spines the central part of the shaft is composed of larger reticulations and a more irregular reticulation (Pl. XXXVIII. fig. 8); while in the smaller spines we find a very open central reticulation passing directly into the ill-defined outer crust (Pl. XXXVIII. fig. 9). This structure of the spines closely resembles that of the flattened spines of *Podocidaris* (Revis. Ech., pl. iv. fig. 15), in which the outer crust is reduced to a very thin layer except where it forms the projections on the extremities of the lines of well separated reticulating spokes. In Plate XXXVIII. fig. 9, the line of demarcation between the outer crust and the coarse reticulation of the shaft is indistinct, and it is only occasionally that in spines like these the outer crust can be recognised and seen to have the essential characteristics we find in the sections of Plate XXXVIII. figs. 7, 8; so that the Arbaciadæ, as far as the structure of the spine is concerned, may be considered to form the passage between the Cidaridæ and the Echinidæ, that is, they have an outer crust as in the Cidaridæ and an inner pith, but the spokes show a tendency to assume a rudimentary monocyclic arrangement, pointing to

that of the Echinidæ. Among the new genera of the Diadematidæ, the spines of *Micropyga* are found to be closely allied in structure to those of *Astropyga*, but with a comparatively larger central foramen and a greater number of calcareous wedges (Pl. XXXIX. fig. 1); while a section across the swollen tip of a spine of the actinal surface (Pl. XXXIX. fig. 2) shows that the solid wedges are reduced to a mere sheath with an inner ring of closely-packed cells arranged in radiating lines, with a dense reticulated central pith.

In *Aspidodiadema* we find indicated, by the structure of the spines as well as by the structure of the test, the affinities of the genus with the Cidaridæ. We find the outer row of calcareous wedges characteristic of the Diadematidæ (Pl. XXXVIII. figs.17–19), with the coarse reticulation of the contents of the shaft as in *Porocidaris* and *Salenia*, and the pith of the central part formed of large and coarse reticulations.

Mackintosh[1] has already given the structural features of the spines of *Asthenosoma*. The structure of the spines of *Phormosoma* (Pl. XXXVIII. fig. 4; Pl. XXXIX. figs. 3–9) agrees in the main with that of *Asthenosoma*. These show close affinity on the one side to the Diadematidæ (Pl. XXXVIII. figs. 1, 2, 4, 5, 6; Pl. XXXIX. fig. 6), and on the other to the Arbaciadæ, in the large irregular reticulation characteristic of the interior of the shaft (Pl. XXXIX. figs. 3–7).

Mackintosh has also figured the same open reticulation in the central part of the shaft of the spine of *Echinothrix*, and has called attention in that genus to the variable character of the solid calcareous wedges forming the outer sheath of the spines (compare Pl. XXXIX. figs. 3, 4, and 6). Among the Echinidæ, even this structure of the interior of the shaft is still found in *Pseudoboletia* (Pl. XXXIX. fig. 11), and it also exists among the Clypeastroids in spines either with or without a central cavity (Pl. XXXVIII. figs. 21, 22; Pl. XXXIX. fig. 19). In fact the spines of the genera of the Clypeastridæ, which I have thus far examined, *Encope*, *Mellita*, and *Clypeaster* (Pl. XXXVIII. figs. 19–22), are interesting from the decided affinities they show to the Echinidæ in the small number of the solid wedges of which they are composed, and in their great resemblance to the monocyclic types of structure of the Triplechinidæ, only that in the Clypeastridæ the shafts are foraminated. In the Petalosticha a similar large foramen exists in the majority of the genera (see Pls. XXXVIII., XXXIX.), and with the exception of the genera *Hemiaster*, *Argopatagus*, and *Rhynchopygus*, in which the wedges resemble more those of the Clypeastroids, we find that the outer ring of large wedges is generally made up of triangular pieces with a rounded apex towards the inner foramen; these wedges are few in number, in some of the genera not more than nine (Pl. XXXIX. figs. 12, 28, 30, 34, 36). This appears to be the general structure of the spines of the Pourtalesiæ, and the allied genera, while in the Spatangoids proper, such as *Lovenia*, *Breynia*, *Eupatagus*, and the Ananchytid-like *Homolampas* and *Linopneustes*, the outer ring is made up of a

[1] Trans. Roy. Irish Acad., xxv., 1875.

greater number of wedges. This outer ring is separated from the inner foramen by an inner ring in which the reticular tissue is very close, as in *Spatagocystis*, *Cystechinus*, and *Pourtalesia* (Pl. XXXIX. figs. 28, 37), or in which it even fills the whole interior of the shaft, as in *Cystechinus* and *Urechinus* (Pl. XXXIX, figs. 28, 30), or is in the normal Spatangoids separated from the central foramen by an inner ring of more or less distinct wedges, the continuation of the larger ring, as in *Lovenia*, *Cionobrissus*, and *Hemiaster*. In some of the genera we find the reticular structure reduced to a minimum, as in *Echinocrepis* (Pl. XXXIX. fig. 32), and in *Periaster* (Pl. XXXIX. fig. 38). From the examination of a number of genera of Clypeastroids and of Spatangoids, there seems to be far less diversity in the structure of the spines in the genera of these two groups than we find in the Desmosticha.

Character of Systematic Affinity of Allied Groups of Echinoidea.

In endeavouring to trace the affinities of the comparatively small number of fossil and living Echinids, it may perhaps be as well to state numerically what we are trying to do, and to show once for all how futile it must be to carry on the attempts which have become so fashionable of tracing the genealogy of this or that group of animals. Very few are so well known from their comparatively unbroken palæontological history as the Echinoidea and none are at the same time limited to so comparatively small a number of species, both fossil and recent. In order to limit the problem still more, we will take it for granted that we may neglect within each genus specific differences as not affecting the case, and take alone the fossil and recent genera, which we will assume to be for the present not more than 225, represented by 2000 fossil, and less than 300 recent species.

The genera of the present epoch—say 107, with 300 species—represent the possible combinations of but a small number of Echinoidea, taking into consideration the number of terms which are variable, which are (in a general way only, of course):—the apical system, the actinal system, the genital plates, the ocular plates and the anal plates, the coronal plates, the ambulacral and interambulacral areas, the poriferous zone, the primary, secondary, and miliary tubercles and their corresponding spines, the modifications of the poriferous zone near the apical and actinal systems, and on the test; the fascioles, the jaws, the alimentary canal, the position of the apical system, of the anal system, of the actinostome, and the modifications of the same. We will say twenty variables which may be, of course, combined in all possible ways one with the other, and which are capable in their most restricted limits of at least 2^{19} combinations; and when we remember that in the 225 genera which we have thus far recognised, we may imagine any one or all the twenty variables affecting the relationship of each of the genera, it seems somewhat hazardous, to say the least, to attempt anything beyond the broadest

indications of the outlines of the relationship; and the very fact that this systematic relationship can still be traced so satisfactorily, not only at the present day, but even in past geological periods, shows us plainly that this range of variations of our twenty variables is far less great than is possible, and is kept within comparatively narrow bounds, otherwise the possible combinations would far exceed our ability to trace them.

In fact, in many classes of the animal kingdom the task of tracing their affinities and reducing them to the factors from which they originated by following the combinations, appears on the face of it a puzzle far exceeding our ability to cope with, and we might as well recognise the very narrow limits within which this problem has any solution. We are brought at once face to face with the number of definite things which we are able to carry in our mind at one time; this number is quite limited compared to the possible combinations which even the smallest number of variable factors represented by the changes the component structural features of any small group of animals may assume. Supposing that for twenty years we became acquainted with one species a minute for ten hours a day, we should not know as many possible combinations as can be formed out of ten such variables as I have mentioned, which affect radically the facies of any one of our 225 genera of Echinoidea; and taking it for granted that the 2300 known species of fossil and recent Echinids are the only combinations which become sufficiently permanent to have transmitted their principal characteristics for a certain space of time sufficiently long to be entitled to recognition as distinct species. We must also remember that the affinities they represent are the result of a far greater number of possible combinations than those to which I have referred, and that even a limited number of species like this baffles all our attempts at indicating these affinities, except in the most general way; or, putting it in a different manner, we are attempting an integration within very distant limits, and are, of course, trying to solve a most difficult problem, which is not a whit nearer its solution by being presented in the customary diagrammatic form of a genealogical tree, no matter how satisfactory this mode of presenting the affinities of the group may appear to its author. But I wish at the same time to be distinctly understood as not calling in question in the least the theory of the direct succession of the Echinids of the present epoch from those of the Chalk, in spite of the hopeless nature of the attempt to represent this succession, either diagrammatically or descriptively.

Relations of the Jurassic Echinoidea to the Echinid Fauna of the present day.

Starting from the Jurassic *Pygaster*, which still has the closest possible relations to the Desmosticha, in which the anal system has passed into the odd posterior interambulacrum, we can readily trace the systematic connection to such forms as *Holectypus*, *Discoidea*, *Conoclypus*, in which the true Clypeastroid features are more and more

developed until the appearance of the Fibularinæ which lead us directly to the Echinanthidæ on the one side, and on the other to the Scutellidæ, through such genera as *Mortonia; Echinocyamus* being the genus in which the clypeaster-like petaloid nature of the ambulacra first appears.

From the time of the appearance of *Galeropygus, Hyboclypus,* and *Pyrina,* we can readily trace the systematic connection of genera which lead on the one side to the slightly modified Cassiduloids of the present day, such as *Echinoneus* and *Echinolampas,* the *Pyrina* types showing evident relationship to the Discoideæ on the one side, and the Echinolampadæ on the other, while *Hyboclypus* may well be regarded as the forerunner of the Ananchytidæ and Collyritidæ, the forms of which are still represented at the present day, and of the Echinobrissinæ which have also survived to the present epoch, while from the Toxasteridæ and the like we pass to *Hemiaster,* which may well be considered as the oldest of the Spatanginæ proper, allied through *Micraster,* to the Holasteridæ, and to which it is not difficult to trace the relationship of all the living genera of Spatangoids. Should we go back to the earliest groups of Echinoidea the Palæechinidæ, let us see how far they show affinities to Echinids now living. In the first place the whole mode of composition of the test is eminently crinoidal from the great multiplicity of plates. It certainly is interesting to find in these earliest Echinids so close a structural affinity in the arrangement of the interambulacral plates with the interradial plates of Crinoids, showing how far-reaching has been Lovén's generalisation in which he compared the apical system of the Echinids to the six primary plates of the calyx of Crinoids. And finally, in a still more general way, we can trace in the embryo Echinoderm of the different orders, whether it be a Starfish, an Ophiuran, a Sea-urchin, a Holothurian, or a Crinoid, the typical structural features which underlie them all.

We trace the existence of the earliest crinoidal structures in the persistency of the central plate with its five radial plates in the embryo Echinoderms of all the orders. We follow in the irregular arrangement of the plates of the dorsal surface of Starfishes, in the repetition of the joints of the arm-plates of the Ophiurans, in the great number of interambulacral plates composing the test of the earliest Sea-urchins, and of many Holothurians, modifications of the branching of the arms of the early Crinoids. The somewhat indefinite distinction of the ambulacral and interambulacral plates in the embryos of Echinids, Starfishes, and Ophiurans dates back to the earliest Cystideans, in which the presence of an apical and anal system still further obscures the nature of the areas. Thus it is that structural features which have apparently disappeared reappear again suddenly, seeming to have no connection with the types immediately preceding them, from the peculiar combination of characters which have remained persistent down to that moment. Yet when we come to analyse the individual characters thus combined, we generally are able to trace them all as modifications of structural features indicated in older periods, but combined together, perhaps, in so novel a way as at first to defy

analysis. These types thus seem on that account to have been introduced suddenly, perhaps, from the great prominence assumed by any one of the Echinodermal structural characters. Characters of very different degree of prominence in the older types, which, slightly modified, might radically affect the structural features of any group.

The modifications of the anal system, of the genital and ocular plates of the test, of the poriferous zone of the actinal system, of the jaws, and so on, do not go on *pari passu*, but, on the contrary, vary not only in every sub-order, but in every family and genus ; consequently, modifications of the coronal plates which affect greatly the outline of the test, and culminate in the Spatangoids, may be combined with other features of very little systematic value in that group such as the position of the anal system. In the same way in the Clypeastroids, the structure of the ambulacra, so widely different from that of the Desmosticha, is found combined with jaws, and again in the Spatangoids a very simple ambulacral system may be combined with an arrangement of the coronal plates, showing the greatest degree of specialisation. We cannot hope, therefore, to trace the development of any type through a series of forms, each slightly different from its predecessor ; we must only expect to be able to follow the changes of a single feature, and study it in its combinations with other features, combinations which from their very nature can never form an unbroken series, as their terms are not synchronous ; combinations which can never be links in any chain beyond the link formed by any one special character in tracing its modifications alone.

It is only in the Archæocidaridæ that we find in the structure of the poriferous zone structural features which have remained unaltered to the present day in all recent Spatangoids, viz., the simple pairs of pores which we find in the Cidaridæ, in the Clypeastroids, and in the Spatangoids ; in the Palæechinidæ we find small tubercles characterising a whole group of genera ; this structural feature, the absence of permanent primary tubercles, still exists at the present day in the highest of our Petalosticha, and is found uninterruptedly in genera living from the oldest time to the present day.

The apical system which we find in the Palæechinidæ still occurs at the present day, but little modified in the Cidaridæ, Arbaciadæ, Diadematidæ, and the tendency to throw the anal system outside of this system is already hinted at in the excentric position of the anal opening in the anal system ; and the compact abactinal system so characteristic of the recent Spatangoids and Clypeastroids is already foreshadowed in the encroachment of the madreporite on several of the genital plates. The specialisation of the plates of the two areas, which takes its greatest development in the petaloid ambulacra of the Petalosticha, can also be traced in a rudimentary form in the double ocular pore of the ocular plate of the abactinal system, the structural features characteristic of the mode of junction of the coronal plates of the Desmosticha, and of the Petalosticha, is also to be traced in the construction of the coronal plates of the test of the Palæechinidæ. The characteristic subdivisions of the test of the Desmosticha into actinostome, coronal and

abactinal regions also exists in these earliest Echinoidea, though it is so modified as to show us how the existence of but a single peristomic system (*Bothriocidaris*) gradually passes into the *Palæechinus* stage, next into the *Cidaris* stage, and finally the *Echinus* stage, and also how it is possible for the peculiar development of the test of the Petalosticha even to be foreshadowed in the absence of lines of demarcation between these systems in the Palæechinidæ, and finally, how the existence of an anal system in one of the interambulacral areas, while calling to mind an eminently crinoidal structural feature, yet at the same time shows the intimate relationship there may have existed between the earliest Spatangoids and the immediate successors of the Cystechinidæ, which thus also may be the precursors of the excentric development of some of the Desmosticha, and of the whole of the Clypeastroids and Spatangoids.

If we examine in the same manner any one of the structural features which have once made their appearance, we find that, without exception, they are either persistent to the present day, or can be traced in a somewhat modified form in some one of the types now living, though the peculiar combination of any definite number of these may have disappeared, and thus radically new elements may seem to have been introduced into certain periods, which are after all only excessive modifications of a single element of structure, which in other forms remains unmodified. This will explain, perhaps, more vividly than any systematic descriptions of affinities the subtle connections which close examination of almost any genus of Sea-urchins at a special period shows not only to the past but also to the future, and the endless links which can readily be traced by a careful analysis between apparently totally disconnected types. Let us take as an example one of the most recent genera,—the genus *Spatangus*,—and see how far back we can trace the structural features, modified so as to be characteristic of *Spatangus*.

The compact abactinal system we can, as I have already stated, trace to the encroachment of the madreporite upon the different genital plates, and the gradual driving out of the anal system into the odd interambulacral zone; or we may go further back and trace this asymmetric arrangement back to its crinoidal affinities, this unequal development of the different radial and interradial zones dating back to the earliest Echinodermal structure, and being also naturally connected with the excentric position of the apical system of the actinostome, and the elongation of the test. The strong contrast between the actinal and abactinal surface goes back to the existence of the earliest Desmosticha. The existence of large primary tubercles dates back to the Archæocidaridæ, that of small primary tubercles uniformly distributed over the test goes back to the Palæechinidæ, the presence of spines of two different kinds is as old as the earliest Sea-urchin, as well as the specialisation of certain parts of the poriferous zone, and the existence of a specialised actinostome.

The development of an actinal plastron dates back to the Galeritidæ, to the first disturbing element which the introduction of the anal system into the odd interambulacral area brought in, and connected with that comes in the development of an anal

plastron, of an anal snout, of a beak or rostrum, and the formation of an actinal lip; connected with these beaks and plastrons are the accumulation along certain lines of bands of miliaries, the fascioles, which can be traced far back in the formation of the so-called miliaries in the first place, and their accumulation at certain points, and finally, their enclosing certain definite areas. If we trace the existence of the slight groove of the anterior part of the test, we go back to the Chalk, and the time when the odd posterior ambulacra began to be developed at a different rate from the others, and to retain its primitive character. The petaloid structure of the lateral ambulacra dates back to the Jurassic period, when the ambulacral areas above the ambitus differed in their proportions from those of the actinal surface of the test. The petaloid structure of the ambulacra adjoining the actinostome began with the oldest Cassidulidæ, and the simple ambulacral pores which connect the actinal and petaloid ambulacral plates we find in a part of the ambulacral zone in the earliest Cretaceous Spatangoids. But the other characters with which the various structural features still found in *Spatangus* are connected in the older genera where they occur are of a very different degree of intensity, and have many of them developed in directions which no longer occur, and have formed types which have become extinct, though the special structure which has been modified still exists.

The peculiar internal appendage which represents the auricles in Spatangoids, and the whole dental system, is reduced to a simple spur, and is the only trace of the complicated dental apparatus which we find in the oldest known Echinids, and which in another direction has remained but little modified up to the present day. Taking in a similar way one of the most characteristic of the older genera, *Ananchytes*, we can also trace backwards to their first appearance, as we have done for *Spatangus*, the genera in which the characteristics of the genus *Ananchytes* are first developed; but we can likewise trace in *Ananchytes* its affinities to the recent Spatangoid genera, and find in the structure of the apical system of the ambulacra, of the anal system, of the actinal plastron, and of the actinostome, indications of lines of development which date back to the genus *Ananchytes*, and which are still to be traced at the present day even though *Ananchytes* is at the present time extinct. Another such characteristic genus is *Pygaster*, in which the whole line of the Clypeastroids is to a certain extent foreshadowed, although if we compare the Clypeastroids to the earlier Echinids, we shall find a far greater number of identical points of structure than when comparing such a recent genus as *Spatangus*.

Adopting the other method, and tracing the development of a single structural feature at a time, such as the growth of the poriferous zone, from the simple paired zone to the complicated ambulacral zone of a Spatangoid, we shall find that the most primitive ambulacral zone known still exists side by side with the existence at the present day of the resultants, if we may so say, of all the combinations which have taken place. In the same way the earliest modifications of the coronal plates of the Palæechinidæ are found to-day to exist in several of the recent Desmosticha, along with a test made up of such a specialised set of

coronal plates as we find in *Moira*. The actinostome of the Palæechinidæ still exists side by side with the anomalous actinal system of *Palæostoma* and the Pourtalesiæ, and the apical system of the Cidaridæ is contemporaneous with the extraordinary combination of the apical and anal system of the Pourtalesiæ, and spines very similar in structure to those so characteristic of the Palæechinidæ are found in the same period with the spines of the Cidaridæ, ofthe Diadematidæ, of the Clypeastroids, and of the Petalosticha.

What has once been gained is never totally lost, it always reappears, not in the previous form but in a slightly modified one, sufficiently preserved to show its systematic connections, and hence the hopelessness of the task to do more than hint at the infinite number of relations which the types of the present day hold to those which have preceded them—relations which with each succeeding formation become more and more difficult to trace in proportion as our knowledge of the older formations is more accurate.

The existence of teeth in most groups of the Echinoidea, no matter how distantly related, is one of the most striking examples of the persistence of a structural feature once introduced, and of its development or modification entirely independent of other accompanying characters. The rate and direction of development of the teeth, of the modifications of the ambulacral system, of the coronal plates, of the anal and actinal systems, do not go on *pari passu* when once a slight modification has become introduced, and thus it is that we have in some of the earlier groups, such as the Collyritidæ and Clypeastridæ, which exist side by side, a widely different degree of complication of structure in the arrangement of the coronal plates, in the structure of the actinostome, in that of the apical system, of the ambulacral system, which have all developed in different directions from their first origin, so as to produce in the one case the Collyritidae, and in the other the Clypeastridae. Thus it is that among the Clypeastroids we find genera with very powerful jaws side by side with genera in which the jaws attain but a slight development, while other characteristic features of the group, such as the arrangement of the coronal plates, the degree of specialisation of the petaloid ambulacra, and the structure of the apical system, may be nearly equally developed.

Thus it is that among some of the Echinolampadæ we find a prominent auricular ring, while it is wanting in closely allied genera. In the same way, in some Spatangina, the large spur developed close to the actinostome in some genera is not found in their closest allies. It is to this same variation in the degree of development of the ambulacral system, combined with a differently developed anal system, coronal plates, fascioles, and actinostome, that we owe the great diversity we find in the recent genera of Spatangoids, and it is to their predecessors in time in the Tertiaries, the Chalk, the Jura or often far earlier, that we must look for the appearance of the structural features which, with the special combinations of structural features which may exist at any one period, give us the facies of the time. We must remember, while making our comparisons, that these structural features, when once they have originated, may either continue as a persistent type of structure

with but slight modifications to the present day, or at the same time may become modified in endless ways, and form the innumerable combinations with other structural features which have given to the Echinid fauna of any period or to that of the present day its typical features.

Connection between the Cretaceous and the Recent Echinid Faunæ.

One of the very first results clearly indicated by the deep dredgings of Count Pourtalès, and the subsequent investigations of the "Porcupine" expedition, was the antique character preserved by many of the new genera discovered in deep water, and especially their resemblance to Cretaceous genera; and the study of the Challenger Echinids has brought this out still more plainly.

For the purpose of making the comparison of the Challenger Echinids with the earlier Cretaceous types as complete as possible, it will be interesting to take a rapid review of the Cretaceous Echinid fauna, and contrast it with the abyssal fauna taken as a whole, independently of its combinations in time with the littoral and continental types, but not independently of its combination with those types which extend into the abyssal fauna either from the littoral or from the continental fauna.

On comparing the genera characteristic of the Chalk with those now found living, we find that a considerable number of the latter date back to the Cretaceous period; and a few of the Cidaridæ, the Echinidæ, the Salenidæ, the Echinoconidæ, and the Petalosticha, even to earlier epochs, to the Jurassic beds, the Lias, and the Trias. The genera *Dorocidaris, Phyllacanthus, Porocidaris, Salenia, Podocidaris* (*Magnosia, Codiopsis*), *Asthenosoma, Phormosoma* (*Echinothuria*), *Temnechinus, Cottaldia, Phymosoma, Holopneustes, Hemipedina, Echinus, Echinocyamus, Fibularia, Echinolampas, Rhynchopygus, Conoclypus* (J.), *Echinobrissus, Catopygus, Pygaster, Pourtalesia* (*Infulaster*), *Hemiaster, Periaster*, are in this category, so that a good proportion of the genera of Echinids still living in the present epoch belong to genera already existing at the time of the earliest Cretaceous formations; and leaving out for the present the genera which have disappeared during Tertiary times, we find in the Tertiaries, in addition to the above genera, the following which have continued to the present time:—*Arbacia, Cœlopleurus, Echinometra, Stomopneustes, Strongylocentrotus, Sphærechinus, Temnopleurus, Trigonocidaris, Salmacis, Amblypneustes, Toxopneustes, Hipponoë, Clypeaster, Echinanthus, Laganum, Echinarachnius, Arachnoides, Echinodiscus, Mellita, Encope, Echinonëus, Nucleolites, Homolampas, Paleopneustes, Spatangus, Maretia, Eupatagus, Lovenia, Breynia, Echinocardium, Brissopsis, Agassizia, Brissus, Metalia, Meoma, Linthia, Schizaster, Moira.*

Leaving as genera belonging strictly to the present epoch, which for the present we may take as the result of the existing condition of things, and as the successors of

the Cretaceous and of the Tertiary forms, the following only:—*Stephanocidaris, Goniocidaris, Diadema, Centrostephanus, Echinothrix, Astropyga, Aspidodiadema, Micropyga, Colobocentrotus, Heterocentrotus, Parasalenia, Pseudoboletia, Echinostrephus, Pleurechinus, Microcyphus, Mespilia, Prionechinus, Evechinus, Peronella, Astriclypeus, Rotula, Neolampas, Anochanus, Palæotropus, Cionobrissus, Echinocrepis, Spatagocystis, Cystechinus, Argopatagus, Palæostoma, Tripylus, Faorina.*

From our study of the embryonic stages of the Echinidæ, the Clypeastridæ, and the Spatangidæ, and a comparison of these stages with the genera of the Desmosticha and Petalosticha which have either succeeded the genera above mentioned, or have lived with them during the Cretaceous period and have disappeared either during the Cretaceous or the Tertiary periods, we find no difficulty in tracing an unbroken systematic connection from the earliest Cretaceous beds to the present time. But this connection is so complicated, and ramifies in so many directions, that it must be hopeless, even with the small number of species of Echinids known, to attempt to do more than to indicate the lines of affinities, the delicate threads of which we can trace in characteristics of genera which at any special epoch seem to have little or no structural affinity. Let us take, for instance, the genera characteristic of the Chalk, and attempt to trace their connection both backwards and forwards in time.

Taking these genera in their most extended signification, and more especially those characteristic of the Lower Cretaceous formations, *Cidaris, Orthocidaris, Phyllacanthus, Tetracidaris, Goniopygus, Codiopsis, Magnosia, Cyphosoma, Pseudocidaris, Orthopsis, Pedinopsis, Codechinus, Stomechinus, Acrosalenia, Echinothuria, Pygaster, Discoidea, Holectypus, Pyrina, Clypeopygus, Pygurus, Metaporhinus, Holaster, Toxaster*, and comparing them in the first place with the genera of the Lias as far as they are known, we find that, with the exception of *Cidaris* and *Hypodiadema*, the forerunners of the Cidaridæ and Diadematidæ, not a single form of the Echinidæ is represented.

To attempt to explain their relationship to the earlier types, we may say in a very general way that the Perischoechinidæ early show on the one side a tendency to limit the number of the rows of interambulacral plates; and on the other side a decided tendency to a splitting up of the ambulacral and interambulacral plates into numerous irregular rows; they are thus the only group leading directly to such types as *Cidaris* on the one side and to the Echinothuridæ on the other, the genera *Tetracidaris* and *Echinothuria* in the Chalk being the representatives of these two groups of Palæechinidæ; while the presence of such a type as *Hypodiadema* early in the Trias may, perhaps, represent the reduction of the number of coronal plates in some of the earlier Echinids, while retaining the uniform tuberculation so characteristic of the Palæechinidæ, and retaining at the same time the proportionally broader ambulacral areas of some of the types. From the time of the Trias the Cidaridæ have been a most persistent type, and the changes the members of the family have passed through are restricted to very narrow limits, with

the exception of the aberrant genera *Heterocidaris, Tetracidaris,* and *Diplocidaris,* which retain more or less Palæechinoid characters while taking on a more modern facies.

The relationship of the Echinothuridæ to the Palæechinidæ I have already insisted upon elsewhere, and their affinities to the recent Diadematidæ are most close. The relationship of *Hypodiadema* to *Diademopsis, Pseudodiadema, Hemipedina,* and to the whole group of Pseudodiadematidæ which culminates in the Chalk, and is only very scantily represented at the present day, is sufficiently near not to need any further elucidation. On the other hand, the development of the Echinidæ is somewhat more complicated, as the affinities of the genera from which we can trace the development of the Echinidæ, the Arbaciadæ, and the Salenidæ is very close in the Liasic, the Jurassic, and the Lower Cretaceous beds; where such types as *Acrosalenia, Hemicidaris, Glypticus,* and *Phymechinus,* show us how readily we may pass on the one hand to the Salenidæ, and on the other to the Temnopleuridæ, the Echinidæ, and the Arbaciadæ. It is, however, only when the interbranching affinities have not extended in too many directions that we can still easily follow the systematic connection, which is as close as we can possibly desire to have it. In fact, it is so extended that we are at a loss to express it satisfactorily.

A few examples will suffice: from the development of *Salenia,* of *Echinus,* of *Temnopleurus,* and of *Arbacia,* we see that these show a very different degree of complication in their systematic relations to the genera which have preceded them in time. The *Saleniæ* retain the simple ambulacral system of the Cidaridæ, the small number of coronal plates, the small number of large primary interambulacral tubercles, the variable shape of the primary spines, the secondary papillæ, the large plates of the abactinal system, and, as far as these features in the Cidaridæ are related to the Palæechinidæ, the *Saleniæ* retain to a less degree the Palæechinid affinities of the Cidaridæ. But in addition to this we find in the *Saleniæ* the presence of a subanal plate, comparatively large ambulacral tubercles, a slight tendency in the ambulacral pores to deviate from the vertical arrangement of the Cidaridæ, and in the imbricating plates of the actinal membrane an apparently very decidedly different structural feature. These last-named features are all features which tend towards the Echinidæ proper, and which thus far have not appeared in the older Cidaridæ, though we find some of these characters already foreshadowed in the imbricating membrane of the Archæocidaridæ, and in the large primary ambulacral tubercles of the Hemicidaridæ. As far as *Echinus* is concerned, the want of prominence of the principal primary tubercles, as well as the greater uniformity in the structure of the spines, recalls again the earliest Palæechinidæ, while the modifications of the ambulacral system also to a certain extent point back to an ambulacral system made up of a large number of plates, as we find most markedly shown again in the more recent Echinometradæ. The actinal membrane is further altered in the direction of that of *Salenia;* we have a smaller number of plates, which in some genera are reduced to ten, the supports of the buccal tentacles, which are the only remnants of the

former uniform extension of the ambulacral pores as far as the actinostome. In the structure of the apical system, the subanal plate can still be traced in some of the stages of growth, while in *Temnopleurus* it never becomes entirely obliterated. In *Temnopleurus* we might say the Salenid abactinal system was more readily traced, and still better in *Arbacia*, while in both these genera the Cidarid features of large primary tubercles is retained in a different degree, and in *Arbacia*, in one part of the ambulacral zone, the arrangement of the pores is of an ancient type, while towards the actinostome its petaloid structure is eminently recent ; the structure of the ocular plate of *Arbacia* leads us back directly to the structure of the ocular plate in the oldest Palæechinidæ.

The affinities of the Clypeastridæ with the Discoideæ are clearly indicated by the development of the longitudinal axis, which dates from the exclusion of the anal from the apical system. We readily trace through *Pileus*, *Holectypus*, and *Discoidea* affinities to *Galerites* and the fossil Conoclypeidæ, while with the appearance of *Galerites*, *Fibularia* and *Echinocyamus* we have the element of the Clypeastridæ and Scutellidæ ; and their relationship to the Cassidulidæ is well shown in the simple ambulacral system of some of the genera, and the rudimentary auricles still to be traced among the Echinolampadæ, while the affinity of the earliest Cassidulidæ, *Hyboclypus*, *Galeropygus*, and the like, to *Pygaster*, which culminate in our day with but slight modifications in *Echinoneus*, show how clearly related the earlier Spatangoids were with the genera to which the Clypeastroids are most closely related, which in their turn still show a most unmistakable relationship to the Desmosticha, so much so that it seems difficult to say whether some of the Echinolampadæ of the present day are not more closely related to the Galeritidæ, from the slight development of the petaloid system and the presence of jaws or of rudimentary auricles.

Already, in the Jura, *Pygaster* shows the method of the passage of the anal system from the interior of the anal ring to the odd interambulacral space, and we find genera such as *Holectypus* and *Discoidea*, in which it occupies in succession all possible positions between the apical system and a place close to the actinostome ; and the passage once effected in the Clypeastroids, we readily go from a mere circular or elliptical opening placed either in the axis, or obliquely or transversely to it, to an opening in a slight groove or a more or less deep groove occupying this same odd interambulacral space, having its climax in the Echinobrissinæ, and then we most naturally pass to an opening holding a certain relation to a more or less distinct beak which, combined with the subanal plastron enclosed by the subanal fasciole, we can gradually trace from a simple plastron flush with the test, as in the earliest Holasteridæ, to the Echinocardiæ, to the Brissinæ, and finally to the Pourtalesiæ, to a plastron extending as a slight beak below the anal system, and finally forming a more or less distinct snout ; and when this is combined with the deep anal groove of other Spatangoid genera we get the remarkable forms such as we have described as belonging to the Pourtalesiæ.

The type of *Holectypus* with its regular outline, its buccal cuts, the anal system on the actinal surface, and the diminution of the size of the tubercles to uniformity in the two areas, the restriction of the poriferous zone to a single vertical row, all tend to show that the tendency to the Clypeastroids is already highly specialised. The existence of such forms as *Pyrina* with their simple ambulacra leads directly to the Nucleolidæ and Echinolampadæ. On the contrary, we can only obtain such forms as the present deep sea types from the earlier Cretaceous types like *Infulaster*, and their derivation from such forms as *Collyrites* seems probable, if we take into account such extraordinary forms as have been figured by Ooster (Echin. Alp. Suisses, pl. x. figs. 1–4), as *Dysaster calceolatus* (see also de Loriol, Echinod. Crét. de la Suisse, pl. xxxiii.).

When we take the Spatangoids of the Chalk, they lead us directly through the Palæostominæ and the Collyritidæ[1] to the Ananchytidæ, which have persisted to the present day; and also to the Spatanginæ proper, represented by but few genera, as *Micraster*, *Hemiaster*, and *Prenaster*, which already possess the structural features characteristic of the recent Spatangoids. That is, we find genera with a peripetalous fasciole, a subanal fasciole, sunken ambulacra, petals of different degree of development, spines specialised on certain areas of the test, a trace of a sunken anterior groove, of an anal beak, of an actinal plastron, of a snout, of a lateral fasciole, and of a specialisation of the primary and secondary tubercles. But, of course, the extent to which these features may be developed in Tertiary and recent genera contrasts often strikingly with the rudimentary nature of the structural features found in the Cretaceous or Tertiary genera. The simple actinostome of the Palæostominæ is combined with a well-marked specialisation of the ambulacra above the ambitus, the petaloid feature of the early Spatangoids which appears later than in the Cassidulidæ; while in the Ananchytidæ the well-developed labium of all the more recent Spatangidæ is combined with a comparatively more rudimentary state of the ambulacral zones.

Among the Cretaceous genera, *Hemipneustes* and *Ennalaster* are extremely instructive. They show, perhaps better than any others, the passage which exists between the earliest Spatangoids with more or less petaloid ambulacra, and the older Spatangoids without petals, and in which the ambulacra have the same simple structure from the apical system to the actinostome. In both these genera the petaloid structure is limited to the posterior poriferous zone of the lateral ambulacra; the only recent genus in which a similar structure still exists is *Agassizia*. In this genus, however, the posterior lateral petals are normally developed as in other Spatangoids, or perhaps we must consider this as the last trace in normal Spatangoids of the simple condition of the ambulacra, such as we still find it in the Pourtalesiæ. It is specially interesting to compare these genera first to the Ananchytidæ, then to the Toxasteridæ, and finally to such recent genera as *Genicopatagus*, *Homolampas*, *Argopatagus*, and the like. These comparisons lead us to detect

[1] The Collyritidæ in their turn showing most striking affinities to such genera as *Hyboclypus and Galeropygus.*

affinities in all possible directions, with the highly petaloid ambulacra of the Spatangoids, with the simplest ambulacral petals of the earliest Spatangoids, or with the embryonic ambulacra of the Pourtalesiæ proper.

Comparison between the Tertiary and Recent Echinids.

In comparing the Tertiary fossil Echinids of the European beds with the species now living in the West Indies, we cannot fail to be struck with the similarity existing between them. It is well nigh impossible to distinguish the species, and even Cotteau hesitates to consider them as specifically distinct. Compare thus the species of *Cidaris, Clypeaster, Echinolampas, Schizaster*, and *Brissopsis*, which are found in the Tertiary beds of Malta, and are no longer found in the Mediterranean, having undoubtedly disappeared from there as soon as the Mediterranean became a closed sea, and the temperature of the water became raised above that of the ocean;[1] while, on the contrary, where the oceanic conditions have not undergone any such great change, we find a remarkable identity in the genera of the Tertiaries and of the surrounding deep sea, as can easily be seen by comparing the Tertiary West Indies types[2] of *Cidaris*, of *Echinolampas*, of *Agassizia*, of *Brissopsis*, of *Schizaster*, of *Eupatagus*, of *Peripneustes* (*Meoma*), of *Hemiaster*, of *Conoclypus*, and of *Echinanthus*, with the species of the same genera now found in the deep waters of the Caribbean Sea and Gulf of Mexico. The presence of Clypeastroids in the Tertiaries of the Mediterranean and Western France forms the connection which once must have existed between the American Clypeastroids and those still found on the West Coast of Africa, and extending from the Red Sea to the Western edge of the Pacific realm. A trace of this old connection is still shown at the present day in the existence of a species of *Mellita* and of *Moira* in the Red Sea.

Forbes, in his Monograph of the Echinodermata of the British Tertiaries, has figured under the name of *Echinarachnius Woodii* two species, one of which is probably a *Rhynchopygus* or a very flat *Nucleolites;* the other, a genus closely allied to one of our deep-sea *Pourtalesiæ;* it has the peculiar snout, thus far known only in that group. The relationship of the species of the older crag to the southern and eastern types was already then insisted upon by Forbes; while the newer crag manifests a more definite connection with the present Fauna of Great Britain, and in the Pleiostocene of Norway and North America we find the common *Strongylocentrotus dröbachiensis*, which is truly an Arctic and boreal species, both in the Atlantic and Pacific Ocean.

Laube[3] describes from the Tertiary beds of Austrian-Hungary a species of *Schizaster*

[1] A similar westward extension of the Tertiary corals of Sicily has been shown by M. Pourtalès, who also finds Tertiary Sicilian corals still living in the deep waters of the Caribbean Sea.

[2] See principally Cotteau, Echinides d'Anguilla; Guppy, West India Tertiaries.

[3] Dr Gustav C. Laube, Die Echinoiden der Oesterreichisch-Ungarischen oberen Tertiärablagerungen K. K. Geol. Reichs Anstalt, Abhandl, v. Heft, No. 3, 1871.

closely allied to the present Mediterranean species *Schizaster canaliferus;* under the name of *Echinus dux,* a species which has all the facies of *Sphærechinus* with the structure of the poriferous zone of *Echinus* proper; also *Echinocyamus,* which varies to such an extent that it is well-nigh impossible to separate many of the more recent Tertiary forms from the species still living. The species described by Laube is remarkable for showing in so large a species the sculpture in the line of the horizontal sutures characteristic of the young stages of *Echinocyamus* such as I have figured in the Revision of the Echini, pl. xiii., while the presence of such a type as *Amphiope elliptica* (*Echinodiscus*) shows evidently the former extension of the genus far to the eastward of its present range; and the existence of species of *Schizaster* like *Schizaster leithanus* (Laube), with very decided *Hemiaster* affinities, enable us readily to see how *Hemiaster* may gradually have been modified into the typical *Schizaster* of the present day. *Spatangus austriacus* seems from Laube's figures to be more closely allied to *Spatangus raschi* than to *Spatangus purpureus,* while *Brissomorpha* is evidently an entirely different type, which unites, like many of the deep-sea Spatangoids lately discovered, characteristic features of several genera. It has the greatly developed posterior interambulacrum forming a regular beak covering the anal system somewhat as we find it in *Echinocrepis,* but it has the labiate actinostome of *Brissus,* with the outline from above of *Echinolampas;* its representative in the present day is *Nacopatagus,* with which it is most closely allied. Manzoni and Mazetti have figured and described in the Atti Soc. Tosc. Sc. Nat., iii. pl. xix. fig. 2, under the name of *Heterobrissus,* one of the Spatangoids with ambulacra flush with the test (but with few pores), which seems to be more closely related to some of the abyssal genera such as *Nacopatagus* than any other; and seems to indicate, from the structure of its petals and the consequent long line of simple pores forming the ambulacral areas, how the present genera, that is, the whole group of the Pourtalesiæ with simple pores, originated and came to persist, retaining the embryonic type through which all Spatangoids primarily pass, the apetaloid state, which is but slightly advanced in *Heterobrissus.*

When we compare the Nummulitic species of Echinids with those now existing either in the littoral, or in the continental and oceanic zones of the Indo-Pacific region, we find that the generic types have continued to the present day, and many species will undoubtedly prove to be identical, on close comparison of more extensive series of the large number of Temnopleuridæ which characterised the Indian Seas of the Tertiary beds with those of the present day, as well as with the species of *Maretia, Brissopsis, Hemiaster, Temnechinus, Echinanthus, Echinolampas,* and other Cassiduloids, which have been figured by Herklots, D'Archiac and Haime.

From the excellent descriptions of the Australian Tertiary Echinids of Duncan, of Laube, and of Tate, we cannot fail to be struck with the existence in the Australian Tertiaries of the genera *Eupatagus, Lovenia, Arachnoides, Echinobrissus, Fibularia,*

Echinanthus, and others, which are in our day still so characteristic of the Australian region.

But there was a time when the peculiar Australian genera of the present day extended far to the westward. Laube[1] figures a most interesting species under the name of *Chrysomelon vicentiæ* and *Chrysomelon pictum*, of which most certainly the nearest allies are not, as he suggests, *Melonites*, but the Australian generic types *Holopneustes* and *Amblypneustes*. In addition to the above the species with decided Pacific affinities are *Sismondia planulata* closely allied to *Laganum bonani* and *Clypeaster breunigii* to *Laganum decagonum*, while *Scutella tenera* represents the American Tertiary element together with a number of species of *Clypeaster* proper and of *Echinanthus*, which, as is well known, obtained a great development in the Tertiaries of Southern Europe, as well as *Echinolampas*, *Hemiaster* proper, and *Schizaster* of a more or less Hemiasteroid facies. From what has preceded, it is evident that, in making these comparisons between the fossils of a district with those still found living at great depths in other areas, we at once find how impossible it is to establish a synchronism from the comparison of identical species in distant formations. Palæontologists have frequently enough felt the futility of attempting to establish merely upon palæontological evidence the synchronism between distant beds supposed to belong to the same formation. This brings us, it seems to me, face to face with the identical problems we are attempting to solve to-day, when stating that the typical Australian Echinids belong to the present Fauna. What have we to support that assertion ?—A single species of *Psammechinus*, a few Triplechinidæ, a few Clypeastroids and Spatangoids, and a couple of species of *Cidaris*.

Now, what has taken place in Australia ? We may picture to ourselves in other times and places the gradual extinction of the Cidaridæ and of the Clypeastroids ; the total disappearance of species still found fossil, but now no longer living, which connect them with the Tertiary period, and only the types of *Psammechinus*, *Goniocidaris*, and a few types characteristic of the Indo-Pacific realm, with the present Fauna, while the typical form *Amblypneustes* is most evidently descended directly from the Chalk, and the wider geographical distribution in space which we have begun to trace among the fossils was also accompanied by a greater persistency in time ; as different a condition of things as possible from the state of things of the present day.

From the comparative lists of Corals from the Tertiaries of the West Indies made by Duncan, it is very evident that the affinities of by far the greater number are with the recent coral Fauna of the Pacific, the Indian Ocean, and the Red Sea, with the Miocene period of the Australian, Java, Indian, and European Tertiaries. What trace there is of the connection claimed by Duncan to have existed between South Europe and the West Indian Islands I fail to see. That this connection of South Europe existed with the

[1] Dr Gustav C. Laube, Ein Beitrag zur Kenntniss der Echinodermen des Vicentinischen Tertiärgebietes. Denk ; d. Kais. Akad. d. Wiss. Wien., xxix., 1868.

most south-eastern extremity of the Pacific Ocean we have the fullest possible proof, but that it extended to the west of the Azores we know not, and we must seek other modes of connection, perhaps across the short space between South America and Cape Verde Islands, certainly not by the North Atlantic, but perhaps by the North South Atlantic. The isolation of the West Indian corals, polyps, and echinoderms dates from the time of the shutting off of the Isthmus of Panama, and probably by areas of elevation synchronous with the rise of the West Indies. These areas of elevation certainly extended far to the south on the west coast of South America, where we can trace them in the succession of the great inland basins forming the great desert of the narrow rainless belt of the coast, the old sea-bottom now flanked by nitrate beds up to a height of 3000 feet; where we also find species of corals identical with those now living, or similar at least to those of the West Indies.

DESCRIPTION OF THE SPECIES.

DESMOSTICHA.

Sub-order DESMOSTICHA, Hæckel, Entwickel. Gesch., 1866 (*emend.*).

CIDARIDÆ.

Family, CIDARIDÆ Müll., Bau d. Echinod., 1854 (*emend.*).

GONIOCIDARIDÆ.

Sub-family GONIOCIDARIDA, Hæckel, Entwickel. Gesch., 1866.

Cidaris.

Cidaris, Klein, Nat. Disp. Echin., 1734.

Many attempts have been made to refer some of the recent sub-genera of *Cidaris* to genera composed thus far of fossil species only. With the exception of the species of the genus *Cidaris* proper, these attempts must be considered faulty, from the usually imperfect state of preservation in fossils of some of the most important characters by which the recent sub-genera have been distinguished. Such important guides as the nature of the pedicellariæ and the structure of the abactinal system are wholly wanting for comparison, and the difficulty of deciding on the relationship from the test and radioles alone, is too well-known to require further comment. In fact, setting aside *Diplocidaris*, *Porocidaris*, and *Goniocidaris*, which are separated from *Cidaris* proper by characters apparently more prominent and permanent than those upon which the other genera among the fossil or recent species are based, we must consider *Dorocidaris* and *Phyllacanthus* as mere sub-genera of *Cidaris*, convenient subdivisions round which a large number of recent and fossil species can be arranged. *Dorocidaris* would include all

forms with narrow ambulacral areas and long slender serrated spines, while *Phyllacanthus* [this subdivision, as I have limited it, is equivalent to *Leiocidaris* and *Rhabdocidaris* of Desor] would include species with broad ambulacral areas, having the poriferous zones joined by a furrow more or less distinct; while *Cidaris* proper would be restricted to species in which the pores of the poriferous zone are not so connected. But thus far no characters derived from the many species described, either fossil or recent, can be given to define these sub-genera with any accuracy. The genus *Cidaris* has since the Triassic period been represented uninterruptedly by a large number of species, and as far as the radioles are known, while some of the types seem characteristic of the Jurassic or Cretaceous, yet from what we know of the extraordinary variations in the spines among the recent species, they hardly furnish a safe guide for any subdivision.

In fact, the species of the genus *Cidaris,* like those of many other genera, present soon after their appearance an extensive series of variations, showing an extraordinary degree of plasticity, which has gradually diminished somewhat as we pass from the Jurassic to the Cretaceous, the Tertiary, and finally the recent species. Among the latter we still find all the principal types of radioles represented, with the exception of the round-headed acorn-shaped radioles, like those of *Cidaris glandifera,* which appeared with the Triassic *Cidaris* and died out during the Cretaceous. This is thus far the only type of radioles of *Cidaris* of which no analogue exists among the species still living at the present day.

The family Cidaridæ is by no means so strictly circumscribed as it would seem from an examination of the living forms alone, and when we come to intercalate such forms as *Acrosalenia*, *Pseudocidaris*, *Hemicidaris*, and *Pseudosalenia*, with *Tetracidaris* and *Diplocidaris*, we find affinities developing among the genera allied to the Cidaridæ, pointing on the one side to the Cidaridæ proper which preceded them in time, and to the Pseudodiadematidæ on the other side, which have such an extraordinary development in the Cretaceous formation, the Cidaridæ types developing into the small groups of Salenidæ and of Cidaridæ proper which have persisted to the present day; and the Pseudodiadematidæ type gradually disappearing and being represented at the present time only by the *Phymosoma* group, and not developing into the Diadematidæ proper, which are evidently the successors of the Perischoechinidæ or the Echinothuridæ of the Chalk; though the structure of the abactinal and actinal systems of some of the Palæechinidæ, as will be seen hereafter, points to a far closer affinity between them and the Cidaridæ than has been hitherto acknowledged. In the descriptions of the young Goniocidaridæ we cannot fail to be struck with their similarity to the St Cassian Cidaridæ, and the tests of the diminutive Cidaridæ of the Trias show at a glance embryonic features, such as the young of all Cidaridæ have, which were at that epoch characteristic of the whole group of Cidaridæ.

The small Cidaridæ of the St Cassian are the most perfect embryonic Cidaridæ imagin-

able; their small size, the gigantic size and often small number of their primary tubercles, as well as the peculiar shape of the primary radioles, all remind us of the early stages of our present Cidaridæ to a degree which can hardly be realised without a direct comparison of the figures of such Cidaridæ as are given by Laube (Fauna d. Schichten v. St Cassian, pls. viii.[b] and ix.) with those of some young Cidaridæ I have myself figured (Revis. Echini, pl. ii.[c] fig. 7); and the variety of form in the radioles found associated with those in the St Cassian beds rivals the disproportions noticed in the spines of young Echinidæ and Cidaridæ such as I have figured in the chapter on young Echini in the Revision (pl. ii.[c] figs. 7–13; pl. v. fig. 9; pl. viii. fig. 16; pl. ix.; pl. x.), and in the Embryology of Echinoderms (Mem. Am. Acad., 1864). It is interesting in the description of the variation in the shape of the spines which we find in *Goniocidaris* to see how early in geological times this variation already existed as a character of the family, and has persisted to the present day.

The oldest species of *Cidaris* in the Trias were small species with smooth tubercles, and the variety of radioles already apparent was considerable. Nearly all the types are represented, but it is almost impossible to separate them, as there is a gradual passage from one to the other. There is a great predominance of clavellate types, a great variety of radioles with secondary spines, and a nearly total absence of the long cylindrical radioles so characteristic of many of the Cretaceous, Tertiary, and recent species. This variation in the spines and gradual transition recalls to us embryonic stages where one and the same species passes rapidly from the state of embryonic species to the state characteristic of the fully grown individuals. When we come to the Jurassic type of radioles the varieties are less closely connected. They arrange themselves more easily into two great types—the glandiarii and the aculei as Desor has named them,—but we must remember that there are still transitional forms, or rather elongated glandiarii with narrow necks approaching the aculei form of the others, and that this formation is characterised by the far greater development of the elongated type of radiole than in the preceding formation, their larger size corresponding to the increase in the size of the test, and the immense development of species characteristic of the Jura which have also mainly crenulated tubercles. This crenulation, however, disappears again during the Cretaceous period, during which the Cidaridæ have smooth tubercles, but, as is the case also in recent species, do not on that account carry smaller radioles. On the contrary, the latter are remarkable for their great length, their greater variety in shape compared with those of the Jurassic period, and more particularly, as has been so well shown by Desor, for the first appearance of the spreading into a corolla of the extremity of the spines so characteristic of some Tertiary genera, and which seems to culminate at the present period in the cupuliform spines of *Goniocidaris*. The glandiform radioles attain a degree of extreme development unknown in the older formations, and they nearly disappear during the Tertiary period,

which contains mainly types of radioles similar to those of *Dorocidaris* and *Cidaris* proper.

The spines of *Rhabdocidaris* are of two principal types, one of which, like those of *R. copeoides,* has also been found in the spines of a recent species; the other, like those of such recent forms as *imperialis*, approaches more to the fossil types of *Phyllacanthus orbignyana.*

Cidaris tribuloides (Pl. I. figs. 2, 3, 5, 6).

Cidarites tribuloides, Lamk., 1816, Anim. sans Vert.
Cidaris tribuloides, Bl., 1830, Zooph.

There exist in several of the European museums small specimens of *Cidaris,* generally labelled "Africa," resembling the young of *Phyllacanthus verticillata,* which they have usually been considered. One or two such young specimens were collected by M. Bouvier at Cape Verde Islands, and are now in the Jardin des Plantes. I did not attempt to incorporate them in my Revision of the Echini for want of sufficient material.

The Challenger dredged at Bahia in 7 to 20 fathoms, and also at Fernando Noronha a few specimens of a *Cidaris,* which at first sight would readily be mistaken for *Phyllacanthus verticillata* (Pl. I. fig. 2). On comparing, however, young *Phyllacanthus verticillata* with the present specimens, we readily note the following striking differences. In *Phyllacanthus verticillata* the verticillations are formed by large prominent lamellæ (see A. Agassiz, Revis. Echini, pl. i.[c] figs. 40–42), while in this species there are a few larger sharper serrations rising irregularly above the general granulation of the shaft, and concentrated on from three to five swellings along the length of the shaft (Pl. I. fig. 3). Otherwise the radioles and papillæ vary in shape much as do those of *Cidaris tribuloides,* and bear the same proportion to the diameter of the test, and the granulation is similar to that of the ordinary type of *Cidaris tribuloides.* The test of the largest specimen collected measures 17 mm. in diameter, and differs in no particular from the test of a normal *Cidaris tribuloides* of the same size.

Similar young specimens having thus far been observed only in localities where *Cidaris tribuloides* occurs, I am inclined to regard them as only a variety of that species. In some of the Challenger specimens, especially the smaller ones, this abnormal decoration exists only in a few of the spines, the other radioles do not differ from those of young specimens of a similar stage of *Cidaris tribuloides.* The differences in the spines of these specimens, and those thus far regarded as the normal *Cidaris tribuloides* are not greater than differences with which we are familiar in the spines of *Goniocidaris tubaria* for instance. In the section of *Cidaris* to which *Cidaris tribuloides* and *Cidaris metularia* belong, no such variation of the spines was

known before, beyond the well-known differences between the spines near the actinostome, the smooth spines near the abactinal system, and the typical primary coronal spines covered with uniform granulation and serration, or the more or less distinct fluting and serrations of the spines of *Dorocidaris*. The discovery in the Caribbean Sea of a species of *Dorocidaris* (*Dorocidaris blakei*, A. Agassiz), with flat fan-shaped radioles, shows that we may expect, even in the genera of *Cidaris* with uniform radioles, an amount of variation in the shape of the spines and their ornamentation fully as great perhaps as that with which we are familiar in *Rhabdocidaris, Goniocidaris*, and the like.

During the "Blake" expedition of 1878–79, a number of specimens of *Dorocidaris blakii* were collected from different localities. These are extremely interesting as showing the gradual passage of a long cylindrical tapering radiole, either fluted or not, with more or less prominent serrations, into a broad flat fan-shaped spine. The detailed descriptions and figures of these spines will appear in the reports of the "Blake" Echinids.

Bahia, 7 to 20 fathoms.

Fernando Noronha, shallow water.

St Vincent, Cape Verde, 15 to 20 fathoms. April, 1873.

Dorocidaris (*Cidaris*).

Orthocidaris, A. Agassiz, 1863, *non* Cotteau.
Dorocidaris, A. Agassiz, 1869, Bull. Mus. Comp. Zool., vol. i.

**Dorocidaris* (*Cidaris*) *bracteata*[1] (Pl. I. fig. 1; Pl. XLII. fig. 1).

Dorocidaris bracteata, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 197.

This species is the Pacific representative of *Dorocidaris papillata*, which has such a wide range in the Atlantic. It is characterised by the small size of the papillæ covering the abactinal area, and the small size of the mammary boss of the primary tubercles, their smaller number compared to specimens of *Dorocidaris papillata* of the same size, the great size of the abactinal area, and the short slender papillæ surrounding the base of the primary spines. The primary radioles are long, pointed, slender, deeply fluted, the fluted edges more or less serrated (Pl. I. fig. 1). The serrations are frequently connected into lamellæ, or in other specimens, those from deeper stations, the serrations are largest and most prominent on the lower third of the shaft; they are very distinct, extending over the whole surface of the spines, and the fluting is scarcely perceptible. The short slender primary spines of the actinal surface are smooth, and strongly fluted. The largest primary spines are twice the diameter of the test. In alcoholic specimens the papillæ of the ambulacral, interambulacral, and abactinal areas are light reddish-brown, the spines

[1] The genera and species first discovered by the Challenger are all marked with an asterisk.

greyish-yellow, and sometimes irregularly banded with brownish-red patches. The difference in the shape of the plates of the abactinal system readily distinguishes this species from *Dorocidaris papillata;* the ocular plates are broadly triangular, extending to the edge of the anal system, which is covered by a smaller number of plates relatively larger than in *Dorocidaris papillata.* The whole abactinal system is covered by finer granules more closely packed than in that species. The ambulacral system is relatively much narrower, both the poriferous zone and the median interporiferous space. The scrobicular area is scarcely sunken, the coronal plates are not high. Otherwise, the test closely resembles that of the Atlantic *Dorocidaris papillata,* but with less distinct and smaller secondary and miliary tubercles.

The short-headed long-stemmed ambulacral pedicellariæ of *Dorocidaris bracteata* differ from those of *Dorocidaris papillata* in being broadest at the base, supported by a longer pedicel and a comparatively more slender rod (Pl. XLII. fig. 1).

Amboyna, 100 fathoms.

Amboyna, 15 to 25 fathoms.

Dorocidaris (*Cidaris*) *papillata.*

Cidaris papillata, Leske, 1778, Kl. Add.
Dorocidaris papillata, A. Agassiz, 1869, Bull. Mus. Comp. Zool., vol. i.

The collections of the Challenger show that this species has an extensive geographical range both in the Atlantic and Pacific. Its distribution in the Western and Southern Atlantic corresponds with that of *Cidaris tribuloides*; the latter has, however, as yet not been found in the Eastern Atlantic north of the Cape Verde Islands, while, as is well known, *Dorocidaris papillata* is found also far north in the North-Eastern Atlantic. The specimens collected in the Philippine Islands cannot be distinguished from those of the Atlantic. The deep water forms generally resemble the variety I had described as *Dorocidaris abyssicola.* The whole question of the specific characters of *Dorocidaris papillata* having been reopened by the discovery of *Dorocidaris blakii,* this identification of the Pacific and Atlantic specimens is of course subject to considerable doubt.

St Paul's Rocks. 70 to 80 fathoms.

Station 24. March 25, 1873. Off Culebra Island; 390 fathoms; mud.

Gomera, Canary Islands; 70 fathoms.

Station 320. February 14, 1876. Lat. 37° 17′ S., long. 53° 52′ W.; 600 fathoms; bottom temperature, 2·7° C.; hard ground.

Station 210. January 25, 1875. Lat. 9° 26′ N., long. 123° 45′ E.; 375 fathoms; bottom temperature, 12·2° C.; mud.

Station 204. November 2, 1874. Lat. 12° 43′ N., long. 122° 10′ E.; 100 fathoms; and 115 fathoms; mud.

Phyllacanthus (*Cidaris*).

Phyllacanthus, Brandt, 1835, Prod. Desc. An.

Phyllacanthus annulifera.

Cidarites annulifera, Lamk., 1816, Anim. sans Vert.
Phyllacanthus annulifera, A. Agassiz, 1872, Revis. Ech., part 1, p. 150.

Mr P. de Loriol [Mém. Soc. des. Sc. Nat. de Neufchatel, vol. v. p. 23, pls. iii. to vi., Mai 1873] has distinguished as *Cidaris lütkeni* a specimen closely allied to *Cidaris annulifera.* The specimens collected by the Challenger of what I take to be (*Phyllacanthus*) *Cidaris annulifera,* show that the variation of the primary and secondary spines is much greater than is admitted by De Loriol, after a comparison of the different spines of the Challenger specimens with those of the Museum of Comparative Zoölogy I am unable to distinguish *Cidaris lütkeni* from *Cidaris annulifera;* De Loriol acknowledges himself the identity of the structure of the test, and bases his principal characters on the variation of the primary spines. They differ in the same specimen sufficiently to be taken as belonging either to the typical *Cidaris annulifera* or to *Cidaris lütkeni,* and even resemble sometimes so closely the spines of *Stephanocidaris bispinosa* as readily to pass for spines belonging to that species.

Station 186. September 8, 1874. Lat. 10° 30′ S., long. 142° 18′ E.; 8 fathoms; coral sand.

Station 188. September 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E.; 28 fathoms; mud.

Cape York.

Phyllacanthus baculosa.

Cidarites baculosa, Lamk., 1816, Anim. sans Vert.
Phyllacanthus baculosa, A. Agassiz, 1872, Revis. Ech., part 1, p. 150.

A specimen from Station 201 is extremely interesting, as it is the only specimen thus far collected of this species in which all the primary spines belong to the type of *Cidaris* proper, resembling to an extraordinary degree the elongated spines sometimes occurring in specimens of *Cidaris tribuloides.* The serrations of the shaft show no trace of the lamellar arrangement forming a more or less prominent fluting of the tip of the spines as in specimens of the typical *Cidaris baculosa;* neither are there any prominent serrations or spines on the shaft such as we find on forms usually considered as specific, viz.:—*Cidaris lima, Cidaris pistillaris,* or *Cidaris krohnii,* but which I have already shown all belong to this species. The specimen figured in Revision of the Echini (pl. i.^{b},

fig. 4) shows two such spines (the black ones on the left) similar to those covering the whole test of this specimen.

Samboangan; 10 fathoms.

Station 201. October 26, 1874. Lat. 7° 3′ N., long. 121° 48′ E.; 82 fathoms and 102 fathoms; stones and gravel.

Phyllacanthus gigantea.

Chondrocidaris gigantea, A. Agassiz, 1863, Bull. Mus. Comp. Zool., vol. i.
Phyllacanthus gigantea, A. Agassiz, 1872, Revis. Ech., part 1, p. 150.

Off Honolulu Reef.

Phyllacanthus verticillata.

Cidarites verticillata, Lamk., 1816, Anim. sans Vert.
Phyllacanthus verticillata, A. Agassiz, 1872, Revis. Ech., part 1.

Station 186. September 8, 1874. Lat. 10° 30′ S., long. 142° 18′ E.; 8 fathoms; coral sand.

Porocidaris.

Porocidaris, Des., 1854, Syn. Éch. Foss., p. 46.

**Porocidaris elegans* (Pl. III., XXXVIII. figs. 12–16; Pl. XLIV. figs. 6–14).

Porocidaris elegans, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 198.

This species can at once be distinguished from *Porocidaris purpurata*, Wy. T., by the facies of the spines (Pl. III. fig. 1) and by the structure of the abactinal system (Pl. III. fig. 2). The interambulacral plates of the test also differ from those of *Porocidaris purpurata* in having a larger row of secondary tubercles surrounding the scrobicular circle (Pl. III. fig. 5). This is complete only in the first and second of the coronal plates nearest the abactinal system, the areas becoming confluent towards the ambitus and actinostome in the remaining plates. The median interambulacral space also differs from that of *Porocidaris purpurata* in having larger secondary tubercles, leaving a space nearly bare between the secondaries, or only sparsely covered by small irregularly arranged miliaries. There is a single row of small secondaries regularly arranged in a vertical line along the median ambulacral space (Pl. III. fig. 6.) with a few intervening miliaries along the median line. The pores are distinct, separated by a prominent median ridge. The primary interambulacral tubercles are surrounded by a large areola. They are small, crenulate, except the last formed near the actinal system.

The genus *Schleinitzia* was established by Studer (Proc. Berlin Acad., p. 463), for a *Cidaris* in which the anal system is allied to that of *Stephanocidaris,* the spines recalling *Porocidaris,* while the crenulation on which he principally based his genus recalls *Rhabdocidaris;* and it may possibly be that Studer's *Schleinitzia* is after all only a new species of *Stephanocidaris* or of *Porocidaris,* more probably of *Stephanocidaris,* since *S. bispinosa,* has crenulate tubercles, and pores joined by furrows.

Thomson (Trans. Roy. Soc., 1874, vol. lxiv., part 2, p. 726), in his description of *Porocidaris purpurata* dredged in the "Porcupine" expedition, had already called attention to the simultaneous occurrence of crenulated and smooth tubercles on the same specimen. He has figured these crenulated tubercles as existing in his specimen mainly round the abactinal system (pl. lxi. fig. 2).

Until the publication of Thomson's paper, which seems to have escaped Studer, it was supposed that the crenulation of the tubercles distinguished the fossil from the recent species as a whole. The unsatisfactory nature of this character, however, was well known from those groups among recent Echinids in which crenulated tubercles occur, and the impossibility of assigning to it any definite value. In the Diadematidæ and Pseudodiadematidæ we find on the same specimens primary tubercles identical in size, which are either crenulated or not. Loriol has expressed his opinion of the variability of this character as regards fossil Cidaridæ, of which the tests are frequently so admirably preserved as to retain the smallest details of structure. Troschel, in 1877, called attention to the presence of crenulated tubercles in a new species of *Cidaris* (*Rhabdocidaris recens,* Archiv. f. Nat., vol. xliii. p. 127). Subsequently Troschel (Sitzungsb. d. Nieder Rhein Gesell., Dec. 8, 1877) returns to the same species, calling attention to the fact that Loriol, on examining his specimens of *Cidaris annulifera* and *Cidaris lütkeni,* found that in both specimens the tests were covered with primary tubercles of which some were crenulated and others smooth. Troschel at the same time shows that his *Rhabdocidaris recens* is closely allied to *Cidaris bispinosa.* On the peculiar structure of the anal system of *Cidaris bispinosa,* radically different from that of other Cidaridæ, I had based the genus *Stephanocidaris* (Bull. Mus. Comp. Zool., vol. i.). I have also examined the tests of *Stephanocidaris bispinosa* and of *Phyllacanthus annulifera* in our collections (Mus. Comp. Zool.), and find that in both these species we have existing on the same tests tubercles more or less distinctly crenulated as well as smooth tubercles. In *Stephanocidaris* the crenulations were limited to those tubercles placed immediately round the abactinal system, which, as is well known, are not the largest nor most characteristic tubercles in the Cidaridæ, and do not always carry spines identical in appearance with the other primary spines of the test. In *Phyllacanthus annulifera,* on the contrary, the crenulated tubercles were found irregularly scattered on the coronal plates. I may add that I was much surprised to find on a specimen of *Dorocidaris papillata* (*hystrix*)

from the Mediterranean, one primary tubercle on the equatorial part of the test showing most distinct traces of crenulation.

I have not found crenulated tubercles in any of the species of *Goniocidaris* I have thus far examined (*Goniocidaris tubaria*, *Goniocidaris geranioides*). In all the specimens of *Dorocidaris* I have thus far examined, the tubercles were all smooth, with the exception of an occasional pit, which may prove to be the first indication of a more definite crenulation in the genus. Even in *Dorocidaris blakii* (Alexander Agassiz, Bull. Mus. Comp. Zool., 1879) no trace of crenulation has been found in any of the specimens I have examined. Yet this species, from its remarkable radioles alone, would, if found fossil, have been referred to *Rhabdocidaris* without any hesitation by every palæontologist.

I hope, in the examination of the series of *Dorocidaris blakii* for the final Report of the Echinids of the "Blake," to have some additional data on this subject, and to enter again into an examination of the crenulation of the tubercles in the other families of recent Echinids in which this character is found, more particularly in the Clypeastroids and Spatangoids, where the crenulation of the primary tubercles is not uncommon in many species on some part of the test.

The mammary boss is prominent and perforate. There are not in either of the denuded specimens of this collection any traces of the muscular impressions on the areola on which Desor characterised the genus, and which, as Thomson has already shown, is not an important feature, being frequently greatly developed in other genera, and depending on the strength of the muscular attachment of the spines. This species and *Porocidaris purpurata* differ in the position of the genital openings. In the present species, in a specimen measuring 41 mm. in diameter, the female openings are large (Pl. III. fig. 2), circular, and entirely within the genital plates; and do not extend, as in *Porocidaris purpurata*, into the interambulacral area. The large female genital openings probably indicate that *Porocidaris elegans*, like *Goniocidaris canaliculata*, is viviparous.

Thomson has described in an alcoholic specimen of *Porocidaris purpurata* the large eggs and ovaries, which resemble those of other viviparous species of *Cidaris*. The position of the genital openings in some of the Cidaridæ (as in *Goniocidaris*) encroaching upon the interambulacral system is interesting, as indicating the first trace of the separation of the genital openings from the apical system. Such an absence of connection, or so indifferent a connection between the so-called genital plates and the apical system, occurs in many groups of Echinids. This connection becomes entirely severed in some species of Clypeastroids. The ocular plates are broader than in *Porocidaris purpurata*. In a younger specimen measuring 28 mm. in diameter (Pl. III. fig. 4) the genital openings were quite small. This specimen may be only a male, or the genital openings may be developed to their full size much later. It is more probable, however, that this example is a young male.

The primary interambulacral radioles (Pl. III. fig. 7) of this species are in the specimens collected more uniform in shape than those of *Porocidaris purpurata*. They are often three times the diameter of the test, cylindrical, slightly tapering, finely striated longitudinally, with minute sharp serrations. They differ from those of *Porocidaris purpurata* in having a short collar above the milled ring, while in the primary spines of *Porocidaris purpurata* the collar is frequently half the length of the spine and of a dark colour, in striking contrast to the white shafts. On the actinal side round the actinostome some of the primary interambulacral spines assume the curved spatula shape with serrated edges so characteristic of the spines of this genus (Pl. III. fig. 8*a*, *b*), the actinal opening is small (Pl. III. fig. 3), and the whole surface is covered by the long imbricating plates of the ambulacral system; the nature of these plates as modified ambulacral plates is readily traced in one of the specimens examined, where the ambulacral plates of the test proper are still partly soldered to the coronal plates. The interambulacral plates, however, appear independently as small plates, and are not ordinary interambulacral plates modified, as is well shown by Lovén (Études sur les Echinoïdées) in his drawing (woodcut, page 29).

The pedicellariæ characteristic of this species are figured on Plate III. figs. 10, 11, 12. In *Porocidaris elegans* the large-headed short-stemmed pedicellariæ, very similar to those of *Dorocidaris*, vary greatly in shape (Pl. XLIV. figs. 6, 7, 11), and the short-stemmed globular abactinal pedicellariæ (Pl. XLIV. fig. 10) are somewhat pyramidal and elongate.

Station 214. February 10, 1875. Lat. 4° 33′ N., long. 127° 6′ E.; 500 fathoms; bottom temperature, 5·3° C.; globigerina ooze.

Station 164*a*. June 13, 1874. Lat. 34° 13′ S., long. 151° 38′ E.; 410 fathoms; grey ooze.

Goniocidaris.

Goniocidaris, Des., 1846, in Agass. et Des., Cat. Rais.

Goniocidaris canaliculata (Pls. II., XLIV. figs. 1–3).

Temnocidaris canaliculata, A. Agassiz, 1863, Bull. Mus. Comp. Zool., vol. i.
Goniocidaris canaliculata, A. Agassiz, 1872, Revis. Ech., part 1.

In the Revision of the Echini, I referred *Temnocidaris canaliculata* (A. Agassiz, Bull. Mus. Comp. Zool., 1863, vol. i. p. 18) to *Goniocidaris*. The material then at my command was not very ample, and the specimens collected by the Challenger at Kerguelen Island, in the Straits of Magellan, and at the Falkland Islands, have brought out some interesting points, showing that the deep vertical sutural line (Pl. II. fig. 4), on account of which this species was removed to *Goniocidaris*, is frequently totally obliterated (Pl. II. fig. 5) by secondary granulation and by tubercles, both in the

median ambulacral and interambulacral spaces, leaving only here and there traces of its former existence. The variation in the length of the spines is also very marked, so that many specimens would at first sight readily pass as *Cidaris papillata* (Pl. II. fig. 1). It was one of these varieties of *Goniocidaris canaliculata* which Thomson described and figured as *Cidaris nutrix* in his Voyage of the Challenger, vol. ii. pp. 226, 227 (fig. 42). There is nothing constant in the connection of these features. We find specimens with long spines and deep median vertical furrows, and the reverse.

Studer (Berlin Akad. Monatsb., 1876, p. 455) has noticed from Kerguelen Island and the coast of Patagonia two species of *Goniocidaris* (*Goniocidaris membranipora* and *Goniocidaris vivipara*), both of which I am inclined to refer to *Goniocidaris canaliculata*. The existence of large genital openings covered by a thin membrane (*Goniocidaris membranipora*) to facilitate the passage of the viviparous young, had not been noticed in the older descriptions, and the differences upon which he separates *Goniocidaris vivipara* from *Goniocidaris membranipora* do not seem to be constant, judging at least from the great variation in the size and position of the genital and ocular plates in the specimens collected by the Challenger, and from the great variation in the length as well as ornamentation of the radioles. Thomson[1] and Studer[2] published about the same time notices that *Goniocidaris* was viviparous, and that the young were carried upon the abactinal system, protected by the upper spines of the test, until their full development had taken place.

On Plate II. are figured three of the most characteristic types of *Goniocidaris canaliculata*, one (fig. 1) with long slender cylindrical spines, some of them twice the diameter of the test. Fig. 2 represents from the abactinal side a specimen with comparatively short radioles, scarcely two-thirds the diameter of the test in length, but the ornamentation of the spines is similar to that of the long cylindrical spines of fig. 1. Both these specimens were covered with comparatively coarse papillæ. In fig. 3 is represented a specimen with much finer and more numerous papillæ, and also slender but short spines. Among the many specimens collected by the Challenger, all possible combinations of fine and coarse papillæ, with slender, long, or short, or with stout and short radioles, were observed, showing, as in other species of the family, a most extensive degree of variation, while in other Cidaridæ with extremely variable spines the characteristic features of the test are tolerably constant. In this species the variation is not limited to the primary radioles and papillæ, but extends also to the ornamentation of the test. This shows, as I have mentioned above, a median suture in all possible stages intermediate between a broad suture (Pl. III. fig. 4), or a deep sharply cut groove (Pl. III. fig. 6), and an almost indistinct bare space (Pl. III. fig. 5).

An interesting account of the mode of carrying the young in this species is given by Thomson (Voyage of the Challenger, vol. ii. p. 228). "The eggs, after escaping from

[1] Journ. Linn. Soc., vol. xiii., June 1876. Berlin Akad. Monatsb., July 1876.

the ovary, are passed along on the surface of the test towards the mouth, and the smaller slightly spathulate primary spines, which are articulated to about the first three rows of tubercles round the peristome, are bent inwards over the mouth, so as to form a kind of open tent, in which the young are developed directly from the egg without undergoing any metamorphosis, until they have attained a diameter of about 2·5 mm.; they are then entirely covered with plates, and are provided with spines exceeding in length the diameter of the test. Even before they have attained this size and development, the more mature or more active of a brood may be seen straying away beyond the limits of the 'nursery,' and creeping with the aid of their first few pairs of tentacular feet out upon the long spines of their mother; I have frequently watched them return again after a short ramble into the 'marsupium.'"

The specimen (Pl. II. fig. 2) shows the manner in which they are held in a sort of marsupium by the folding of the abactinal spines over the young crowded upon the abactinal system. This, as is shown in Plate II. fig. 7, cuts deeply into the median ambulacral and interambulacural spaces. The female genital openings are notched in the very edge of the genital plates.

From among the many young collected by the Challenger, I was able to obtain two most interesting stages of growth of this genus. Plate II. figs. 9, 10, represent from the actinal and abactinal sides a young *Goniocidaris*, in which we find as yet no separation of ambulacral or interambulacral plates. These areas are, however, most distinctly marked by the presence of large primary tubercles and spines in the latter area, and by the presence of three pairs of small tentacles in each ambulacral zone, surmounted by a huge odd terminal tentacle (Pl. II. figs. 9, 10, 18). The ambulacral tentacles are separated by a vertical row of tubercles carrying small primary spines, but the test is not subdivided into zones by plates; it is as yet composed only of more or less close reticulation and irregularly shaped plates, thickly covered with pigment spots. I attempted in vain to find the eye at the base of this huge odd terminal tentacle, the homologue of course of the odd terminal tentacle of the ray of the starfish, in which we can so easily trace the eye in very early stages. The mass of pigment covering the test, spines, and tentacles, made it impossible to observe the eye if it does exist. I have also failed to see the eye in the young Echinids of other genera[1] which I had occasion to examine, many of which were less advanced than the young of *Goniocidaris* here described. This stage is interesting as showing perhaps more plainly than in any other young Echinids I have seen, that the abactinal system is developed simultaneously with the coronal plates from the primary reticulation of the test, while the actinal system on the contrary is from the earliest stages separated as such from the coronal plates. In a view from the actinal side (Pl. II. fig. 9) the ten buccal tentacles are well

[1] See A. Agassiz, Mem. Am. Acad., vol. ix, 1864, Embryology of Echinoderms; and A. Agassiz, Embryology of the Starfish, 1864, in Agassiz's Cont. Nat. Hist. U. S., vol. v.; also Memoirs Mus. Comp. Zool., vol. v., No. 1, 1877.

seen. The anus already opens in the centre of the abactinal part of the test (Pl. II. fig. 10). The spines at this stage (Pl. II. figs. 9, 10) have already assumed much more the general appearance of those of the adult than is usually the case among young Echinids. In the next stage (Pl. II. fig. 12) the tentacles are contracted, the spines are much longer, the tubercles well formed, the papillæ commence to be formed on the abactinal system, and the plates composing the ambulacral and interambulacral areas can readily be distinguished (Pl. II. fig. 8). Judging from the proportion of the spines to the test, this is probably the young of a long-spined specimen. One of the short-stemmed pedicellariæ of the abactinal region of the test (from a full grown specimen) is figured on Plate II. fig. 15, one from the test (fig. 17), and the same kind in different stages of development (fig. 16).

In *Goniocidaris canaliculata* the long-stemmed ambulacral pedicellariæ (Pl. XLIV. fig. 1) have an elongated triangular head, supported upon a comparatively stout rod (Pl. XLIV. fig. 3).

Station 149, Royal Sound, Kerguelen. January 17, 1874. Lat. 49° 40′ S., long. 70° 20′ E.; 25 fathoms.

Balfour Bay, Kerguelen; 20 to 60 fathoms.

Station 315. January 26, 1876. Lat. 51° 40′ S., long. 57° 50′ W.; 5 to 12 fathoms; sand and gravel.

Kerguelen Island. January 19, 1874.

Station 151. February 7, 1874. Off Heard Island; 75 fathoms; mud.

Station 313. January 20, 1876. Lat. 52° 20′ S., long. 68° 0′ W.; 55 fathoms; bottom temperature, 8·8° C.; sand.

Off Christmas Harbour, Kerguelen Island; 120 fathoms.

Stanley, Falkland Islands; 5 to 10 fathoms.

Station 150. February 2, 1874. Lat. 52° 4′ S., long. 71° 22′ E.; 150 fathoms; bottom temperature, 1·8° C.; rock.

Station 153. February 14, 1874. Lat. 65° 42′ S., long. 79° 49′ E.; 1675 fathoms; mud.

Station 156. February 26, 1874. Lat. 62° 26′ S., long. 95° 44′ E.; 1975 fathoms; diatom ooze.

Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E.; 1600 fathoms; bottom temperature, 0·8° C.; globigerina ooze.

**Goniocidaris florigera* (Pl. I. figs. 7–20; Pl. XXXVIII. fig. 11; Pl. XLII. figs. 2, 3; Pl. XLIV. figs. 4, 5).

Goniocidaris florigera, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 198.

In no species of the family (excepting *Dorocidaris blakii*) do I know so great a difference between the primary radioles of different parts of the test. In one of the

specimens the most prominent primary spines are cylindrical, slightly curved, some of them more than twice the diameter of the test in length (Pl. I. fig. 12), tapering so little that at the extremity, which is probably broken or worn, they are nearly of the same diameter as at base. These long spines recall the spines of *Salenia hastigera*, and remind us among the fossil Cidaridæ very strongly of the cylindrical spiny radioles of some species of *Rhabdocidaris*. These largest radioles are smooth, covered irregularly by sharp spines, equalling its diameter in length near the base of the radioles (Pl. I. fig. 18). These spines are large and few in number near the base, becoming more numerous and smaller towards the extremity of the radiole. Near the ambitus the radioles are shorter and more slender; the serrations, closely crowded, sometimes form an irregular fluting (Pl. I. fig. 19), or they resemble the long curved cylindrical primary radioles. Immediately around the abactinal area the primary spines, while similar in structure at the base to the more prominent spines, are remarkable for the immense dilatations of the tip (Pl. I. fig. 12), the points of which frequently ramify, forming a flattened cup equalling in diameter one-third the diameter of the test (Pl. I. figs. 15, 16).

In *Goniocidaris tubaria* and *Goniocidaris geranioides* we find similar cupuliform spines near the abactinal region, but the spreading of the tip of the radioles is not so great in proportion to the diameter of the test. The papillæ covering the abactinal area are small, with the exception of a few immediately surrounding the anal opening (Pl. I. fig. 12*a*); those at the base of the primary spines in the interambulacral areas are short and broad, in striking contrast to the remarkably slender and delicate papillæ of the ambulacral area. There is a marked contrast in the curve of the actinal and abactinal portions of the test; the former is much more convex than is usual among Cidaridæ, the outline of the test when seen in profile resembling somewhat the shape of the test of *Echinostrephus*. In another specimen (Pl. I. fig. 7) there are on the actinal side only a few of the cylindrical spines such as were characteristic of the first specimen (Pl. I. fig. 12), the other primary interambulacral radioles being very uniform in character, slightly swollen above the collar, gradually tapering to a point, with large spines scattered over the whole surface of the shaft (Pl. I. figs. 8, 9). There are no cupuliform spines near the abactinal system. The radioles are somewhat longer than the diameter of the test. The ornamentation of the test is limited in this species to small deep pits at the angles of the plates in the median interambulacral lines (Pl. I. figs. 13, 14). The greater part of the coronal vertical sutures are edged by irregular minute ridges, showing in the interval left between them the deep narrow sutural line near the ambitus. Near the abactinal pole the vertical suture is reduced to a sharp line. The secondary tubercles of the scrobicular area are in contact along the horizontal lines of sutures (Pl. I. figs. 13, 14). Coronal plates high, mammary boss small, scrobicular area deep.

Along the horizontal suture, at the junction of the coronal plates with the poriferous

zone, a small ill-defined pit exists. The poriferous zone is narrow, the pairs of pores separated by high ridges are somewhat wider in the central part. The median ambulacral area is wider than the poriferous zone. The ambulacral plates are separated from the poriferous zone by a vertical row of distinct secondary granules. The lower part of the ambulacral plates is occupied by minute granules, leaving distinct bare spaces forming small rectangular pits, which alternate for the whole height of the ambulacral area (Pl. I. fig. 13). The larger granules carry short, slender, sharp papillæ, while the miliary granules carry diminutive papillæ scarcely equal in length to the height of the ambulacral plates. The ocular plates are heart shaped. The genital plates are heptagonal, separated by large pointed plates from the anal system, which extends to the ocular plates. The genital openings are large, situated nearer the centre of the plates than the edge. The anal system is covered by a single row of ten larger plates adjoining the genital plates, with smaller irregularly-shaped plates in the centre. The whole abactinal system is closely covered with indistinct tubercles carrying short sharp papillæ, somewhat largest around the anal opening. The outer part of the coronal plates not occupied by the scrobicular tubercles is closely packed with minute granules carrying diminutive papillæ similar to those of the median ambulacral space. The colour of the spines of alcoholic specimens is white; the papillæ round the base of the primaries are light reddish-yellow. This species is remarkable for its small actinal opening.

In a specimen measuring 27 mm. in height, in which there are seven primary tubercles, the diameter of the test is 26 mm.; the diameter of the actinal system, 11 mm.; and that of the abactinal system, 13 mm. The length of the longest curved primary spine is 56 mm.

The ornamentation of the sutures of this species, extending over the greater part of the coronal plates, shows the affinities of *Goniocidaris* with *Temnocidaris* of Cotteau (not A. Agassiz); see Pal. Française, Pl. 1085–1087 (*bis*).

The short-stemmed globular-headed interambulacral pedicellariæ of *Goniocidaris florigera* (Pl. XLII. fig. 3) are remarkable for the great size of the basal part of the head and the small open foramina left between the terminal prongs of the head. These are larger than we usually find them in the corresponding pedicellariæ of other Cidaridæ.

The shape of the long-stemmed narrow-headed ambulacral pedicellariæ is shown on Plate XLII. fig 2. On the test the globular-headed short-stemmed pedicellariæ are more elongate (Pl. XLIV. fig. 5), and the terminal prong of the valves is stouter.

Station 192. September 26, 1874. Lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud. Ki Islands.

Station 204. November 2, 1874. Lat. 12° 43′ N., long. 122° 10′ E.; 100 fathoms and 115 fathoms; mud.

Goniocidaris tubaria (Pl. XL. figs. 1–25).

Cidarites tubaria, Lamk., 1816, Anim. sans Vert.
Goniocidaris tubaria,[1] Lütk., 1864, Bid. til Kund. om Ech.

A large number of specimens of all sizes were collected off Moncœur Island, Bass Straits. This has enabled me to examine the range of variation of the primary radioles of this species; the principal ones are figured on Plate XL. figs. 1–25.

From the sections of spines of *Cidaris* it is evident that the variations of the shape and of the size of the appendages is entirely due to the greater or less development of parts of the sheath of the radioles characteristic of the Cidaridæ. The differences in the shape of the radioles noticed on the same specimens of genera of *Cidaris*, of *Dorocidaris*, of *Porocidaris*, of *Phyllacanthus*, of *Goniocidaris*, &c., in fact, of all the recent genera of Cidaridæ, show the utter impossibility of distinguishing the species of this family by any differences in the shape of the primary radioles. The secondary ornamentation, such as the granules, their size and arrangement, is a far better guide, but the effect of this is apt to be greatly modified when we find it on a deeply fluted radiole, a flat fan-shaped or a highly serrated primary spine. The greatest caution must be exercised in using even this character, and the determination of species of *Cidaris* by palæontologists from fragments of radioles, or even from primary radioles, appears to be, judging from our knowledge of the recent types, of but little value. With the exception of the club-shaped radioles, such as *Cidaris dorsata* (Braun), *Cidaris rœmeri* (Wissm), from the Trias, *Cidaris glandifera* (Goldf.) and the like, from the Jura, and *Cidaris clavigera* (Kœn) from the Chalk, there are none of the many differently shaped radioles, probably belonging to Cidaridæ of the Jura or of the Chalk and Tertiary, which are not represented in species living in the seas of the present epoch. So that, as far as the Cidaridæ are concerned, we have, with the exceptions mentioned above which have disappeared, and with the exception of *Diplocidaris* and *Tetracidaris*, the same generic types now living which characterised first the Jurassic, then the Cretaceous, and finally the Tertiary seas.

From the fact that the Cidaridæ like other Echinids, in fact, like all Echinoderms, are gregarious, we ought to be exceedingly cautious in characterising a formation or a bed from the fossil Echinids of any special locality. No better instance of the negative character of such evidence could be given than the hauls made at different depths in regions not very remote geographically. The experience of all deep-sea dredging, and, in fact, of dredging even at moderate depths, seems conclusive. A few instances will suffice.

Thomson often brought up in the "Porcupine" immense numbers of *Echinus norvegicus*, *Cidaris papillata*, *Spatangus raschi*, and *Brissopsis lyrifera*.

[1] In the Revision of the Echini, I did not refer this to Lütken as I should have done, see Revis. Echini, pp. 77, 131, 213, 397.

In the Challenger the different species of Pourtalesiæ, of Echinothuriæ, of *Hemiaster*, of *Schizaster*, of *Goniocidaris*, of *Cidaris*, came up in numbers from certain localities.

My own experience has been identical, not only while collecting near the shores the masses of *Strongylocentrotus dröbachiensis*, of *Arbacia*, of *Echinarachnius*, of *Mellita*, of *Clypeaster*, of *Encope*, of *Rhynchopygus*, of *Moira*, and in deep waters, of *Asthenosoma*, *Salenia*, *Aspidodiadema*, *Paleopneustes*, and more particularly the species of *Cidaris*, which, certainly if we had characterised our beds from such species as *Cidaris tribuloides*, *Dorocidaris papillata*, *Dorocidaris blakii*, or *Porocidaris*, would give to a bed a very different facies based upon very local distribution and occurrence in great numbers at different localities. The same is true of the dredgings of Starfishes, Ophiurans, and Holothurians.

I have figured on Plate. XL. figs. 1–25, the differently shaped spines which occur on specimens of *G. tubaria*. They have been selected to show the modifications of a simple tapering spine (Pl. XL. fig. 19), with slight nodes so as to form on the one side the spiny, slightly cupuliform primary spines (Pl. XL. fig. 1), and on the other the short, cupuliform spines (Pl. XL. fig. 18) characteristic of the abactinal part of the test, and the elongate, slightly spinose, and but little cupuliform spines (Pl. XL. fig. 16) which give the extremes of the forms of spines found in *Goniocidaris tubaria*. At the same time, the intermediate forms showing the passage between these three extreme types give an excellent idea of the great variation of the radioles in the genus *Goniocidaris*, and of the impossibility of drawing reliable specific characters from the shape of the radioles alone, even when taking carefully into account the ornamentation of the spines themselves, the nature of which is frequently obliterated by the important changes in outline which characterise the primary spines. This of course applies not only to this genus but in general also to the species of the family Cidaridæ.

Station 161. April 1, 1874. Off entrance to Port Philip; 38 fathoms; sand.

Station 162. April 2, 1874. Off East Moncœur Island, Bass Straits; 38 to 40 fathoms; sand.

Salenidæ.

Sub-family *Salenidæ*, Agassiz, 1838, Mon. Ech. Salénies (*emend.*).

Salenia.

Salenia, Gray, 1825, Ann. Phil.

Tertiary *Saleniæ* are now known from France and from Australia, and also from Sindh.[1]

[1] Cotteau, Rev. and Mag. Zool., Mai. 1860.

The *Salenia tertiaria* of Tate[1] is carefully described by Duncan.[2] He mentions the numerous ambulacral tubercles in four vertical rows somewhat as in *Salenia hastigera*, and more especially the presence of but a single pair of pores to each tubercle as in the recent Salenidæ, while this is not the case in the older fossil Salenidæ; and it is somewhat remarkable to find this structural feature in the Tertiary species, for, from what we know of the mode of development of the ambulacral regions in other Echinids, the character just alluded to in the older Salenidæ is not an embryonic one, as the crowding of the poriferous zone is, as far as we know, now prominently developed only in the older stages of growth of the Desmosticha. The *Hemicidaris* character of the existence of a few large primary tubercles near the actinostome is quite striking in *Salenia varispina*, and much less so, though it exists, in *Salenia hastigera*.

Duncan has described in the Annals and Magazine, vol. xx. p. 70, the sphæridia of a species of *Salenia*, dredged by the Challenger, which he names *Salenia profundi;* and on the strength of the presence of sphæridia and their absence in the Cidaridæ, as well as the character of the buccal membrane, he retains the Salenidæ as an independent family, and as more closely allied to the Echinidæ proper than the Cidaridæ, with which I had associated them more closely than other authors had done. I, however, hardly think that the single additional structural point he mentions (the existence of sphæridia) is a sufficient ground for taking what I consider a retrograde step in our ideas of the affinities of the Salenidæ.

An unfortunate misprint occurs in my description (Revis. Echini) of *Salenia varispina*. While speaking of the imbricating buccal membrane, it reads "much as in *Echinocidaris;*" it should have been "as in *Trigonocidaris.*" I may be allowed to state that I was fully aware that *Echinocidaris* is identical with *Arbacia*, as Dr Duncan states (see Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 248), and also that the imbricated plates of *Salenia varispina* show on my figures (Revis. Echini, pl. iii.); and as I have shown, this is an important difference between *Salenia hastigera* and *Salenia varispina*.

As Duncan justly remarks with regard to the number of the primary tubercles, their number cannot be limited to ten as I had stated it in the Revision; but, on the other hand, his statement that the number of primary tubercles is indicated long before the test assumes its largest size, will have to be greatly modified judging from the young *Saleniæ* dredged by the "Blake." To this point, however, and to the relationship of *Salenia varispina* to *Peltastes* or *Hyposalenia*, I shall return in the final Report of the Blake Echinoidea, when giving an account of the changes undergone by *Salenia* during growth, which affects materially the position of the anal system. I should say, however, that the single specimen of *Salenia* on which my original description in the Revision was based appears to be somewhat anomalous in the size of the anal system, and its degree of encroachment on the genital plates. I do

[1] Tate, Quart. Jour. Geol. Soc. London, vol. xxxiii. p. 256, fig. 2, p. 257.
[2] Duncan, Ann. and Mag. 1878, vol. ii. p. 61.

not wish to maintain untenable views, and not to seem to yield to apparently overwhelming evidence as to the way to use the position of the madreporic body to ascertain the axis of the body. It is not my intention to argue the question anew, but I must reiterate that no evidence has as yet been advanced disproving the position I start with, that the madreporic body is placed at the suture of the embryo Echinid formed by the junction of the ends of the open spiral forming the young Sea-urchin in the Pluteus, and no amount of observation on the abactinal system of young forms after they have resorbed the Pluteus, or in the adult stages, will throw any light on that point. I cannot see the force of the distinction made by Dr Duncan between embryonic spines and papillæ, which he says cover the apical disc, because they are not placed on tubercles. No young spine of any Sea-urchin is articulated when it first appears, nor is it placed upon a tubercle, and I merely intended to denote the fact that these appendages were embryonic spines, from their greater similarity to young spines, and remained so; and it does not seem to make a material difference in the description if we call them papillæ.

From the careful description of Duncan's *Salenia profundi*, which is the name he gives to his species, it is evident that it is more closely allied to *Salenia gœsiana*, of which it may be the adult, and that it differs very considerably from *Salenia varispina* (A. Agassiz); but not having seen Dr Duncan's specimen I am unable to associate it with *Salenia hastigera*, the spines of which differ radically from his. All the specimens (five) collected by the Challenger in the Bay of Biscay and off the coast of Portugal belonged to the species which I have here called *Salenia hastigera*, and have figured on Plate IV. of the Challenger Echinoidea. As these specimens were among the first returned to Sir Wyville Thomson before Dr Duncan's description appeared, I am unable to examine them again and compare them with Dr Duncan's description. Thomson's figures, on pp. 145 and 146, Voyage of the Challenger, Atlantic, vol. i., evidently represent *Salenia hastigera*. This is not the only instance of a Pacific species being found off Portugal. The same is the case with *Aspidodiadema tonsum*.

With regard to the crenulation of the primary tubercles, the primary ambulacral tubercles near the astinostome are certainly, as I have stated, crenulated like the primary tubercles of the interambulacral areas; but the secondary ambulacral tubercles, which continue the line of the larger primaries to the abactinal system, are not. My description was not sufficiently complete, and I should perhaps have stated that the smaller ambulacral tubercles are not crenulated. I did not attach special importance to this character, beyond stating the fact of its existence, on account of the great difference there is known to exist in other Echinidæ with reference to this very point. I must also add here that the large primary tubercles near the actinostome in *Salenia hastigera* are also distinctly crenulated, but the smaller ones are not. The structure of the spines most emphatically associates the Salenidæ with the Cidaridæ, as a cross section

will show at once; the verticillation also of *Salenia hastigera* is not produced as in the Diadematidæ, but by the regular arrangement of the processes of the outer sheath as in the Cidaridæ.

There still remains also the other important feature, thus far found only among the Cidaridæ, the peculiar nature of the secondary spines forming, as in the Cidaridæ proper, the rows of papillæ regularly arranged in the intertubercular spaces of both areas, and forming also the secondary spines. The jaws and teeth of *Salenia* do not give as definite information regarding the affinities of the genus. The teeth of *Salenia hastigera* are, like those of the Echinidæ proper, keeled, though with a broad flat keel, while the compact nature of the pyramid with its small apical foramen, and the proportionally large size of the tooth, brings them into close proximity to the Cidaridæ, between them and the Arbaciadæ; nor is the presence of gills and slight gill cuts an objection to their association with the Cidaridæ.

I have already called attention, in the Revision, pp. 645 and 694, to the existence of openings for the passage of gills, and their protrusion through these openings when alive, in our Florida species, although Müller denies their existence. Mr Charles Stuart (Trans. Lin. Soc., Dec. 1877) has given excellent figures of organs which are undoubtedly gills placed within the imbricating membrane, but has not traced their extension outwards. Whether it is these organs (gills) which find their way through the cuts or not in our Florida species I am unable to state, and a renewed examination of living specimens will be necessary before we can settle this interesting question.

I am not the only writer on Echinids who has associated more closely than has usually hitherto been done the Salenidæ and Cidaridæ. De Loriol had previously, in the Echinol. helv., taken very much the same ground, though he subsequently modified his view, and now inclines to unite the Salenidæ to the Glyphostomes as a tribe, and not to the Cidaridæ, which he contrasts to the other regular Echinids as Holostomes. I do not feel that this character taken by De Loriol can be employed to denote primary subdivisions among the Echinoidea, for among the Diadematidæ and Echinothuridæ we at once find forms, otherwise closely allied, which differ radically in this one point considered so essential by De Loriol, and as fast as new material accumulates both among living and fossil Cidaridæ it little by little shows the insufficiency of characters on which we have been accustomed to contrast so strongly the Cidaridæ with the other families of the regular Echinids. I need only mention here the enormous difference made in our estimate of the value of the family character of the Cidaridæ by the discovery of such genera as *Diplocidaris* and *Tetracidaris*.

* *Salenia hastigera* (Pl. IV. figs. 3–17; Pl. XXXVIII. fig. 10).

Salenia hastigera, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 198.

This species differs from *Salenia varispina*, A. Agassiz (Revis. Echini, pl. iii. figs. 8–14), in the closer and uniform granulation covering the abactinal system, and the more central position of the genital openings (Pl. IV. fig. 10). The primary spines are comparatively much longer, some of them equalling four times the diameter of the test (Pl. IV. fig. 3). They are more or less cylindrical, varying but little in shape. Though they are usually straight, sometimes considerably curved, they taper very gradually and are covered from the base to the tip with numerous small sharp spines closely arranged in regular rings round the shaft (Pl. IV. fig. 17). On the longest radioles the small spines are frequently worn off, the extremity of the shaft showing only a delicate longitudinal striation. The primary radioles of the actinal surface are similar to those of *Salenia varispina*, but, although flattened and with few sharp spines along the margin, are quite slender. The spines of the median interambulacral space and of the ambulacral region are short club-shaped but less variable in outline, and more slender, especially towards the abactinal region, than the corresponding spines of *Salenia varispina*. The apical system of *Salenia hastigera* conforms entirely in the arrangement of its plates with that of the normal *Salenia*, the anal system being surrounded by two of the genital plates and by the subanal plate.

In young specimens of *Salenia varispina* the anal system encroaches only upon one of the genital plates, and subsequently in older specimens the position of the anal system does not differ in the two species. In none of the specimens of *Salenia hastigera* examined, even the smallest, do we find any indications of the deep pits along the lines of sutures of the plates of the abactinal system, such as are so well-marked in young specimens of *Salenia varispina*. The madreporic body is not more prominent than in the other species of the genus; it consists of only four to six small openings adjoining one of the genital openings (Pl. IV. fig. 16). The ocular plates are proportionally longer and narrower than in *Salenia varispina*. The anal system is covered by a number of plates irregularly arranged in two to three concentric rows round the anal opening; they carry small papillæ. In a younger specimen the plates immediately round the anal opening (Pl. IV. fig. 12) are triangular, much as the plates covering the whole anal system of *Salenia varispina*. With this exception and the comparatively larger size of the ten buccal plates of the actinal membrane, the smaller specimens of *Salenia hastigera* (Pl. IV. figs. 12, 13) already possessed the characteristic features of the larger specimens. The number of primary tubercles in the interambulacral area is smaller in this species (Pl. IV. fig. 15) than in *Salenia varispina* (Pl. IV. fig. 1), in the proportion of six to eight; and in the ambulacral area at the actinostome we find only two or three large tubercles (Pl. IV. fig. 14), while in *Salenia varispina* (Pl. IV. fig. 2) they form, as in

Hemicidaris, a row of tubercles regularly decreasing in size towards the abactinal system. The secondaries surrounding the primaries are also more numerous and more closely crowded in *Salenia varispina* than in *Salenia hastigera*. I dredged in the "Blake," during the season of 1878–9, an extensive series of young *Saleniæ* (*Salenia varispina*), which will be fully described in my final Report of the Blake Echini.

Station 106. August 25, 1873. Lat. 1° 47′ N, long. 24° 26′ W; 1850 fathoms; bottom temperature 1·8° C.; globigerina ooze.

Station 195. October 3, 1874. Lat. 4° 21′ S., long. 129° 7′ E.; 1425 fathoms; bottom temperature, 3·0° C.; grey ooze.

Station 170. July 14, 1874. Lat. 29° 45′ S., long. 178° 11′ W.; 630 fathoms; bottom temperature, 4·0° C.; rocks.

Station 171. July 15, 1874. Lat. 28° 33′ S., long. 177° 50′ W.; 600 fathoms; bottom temperature, 4·0° C.; rocks.

Station 335. March 16, 1876. Lat. 32° 24′ S., long. 13° 5′ W.; 1425 fathoms; bottom temperature, 2·3° C.; globigerina ooze.

Off Cebu, 100 fathoms.

Off Macio, 1700 fathoms. September 11, 1878.

Bay of Biscay and Coast of Portugal, January and December 1872 and 1873.

Salenia varispina (Pl. IV. figs. 1, 2).

Salenocidaris varispina, A. Agassiz, 1869, Bull. Mus. Comp. Zool., vol. i.
Salenia varispina, A. Agassiz, 1872, Revis. Ech., part 1, p. 155.

A number of specimens of this species were dredged by the Challenger, and I have been able to supplement in many points the first description based upon a single specimen dredged by M. Pourtalès. These additional characters I have called attention to in the comparative description of the preceding species, *Salenia hastigera* with *Salenia varispina*. *Salenia varispina* is more closely allied to *Salenia gæsiana* of Lovén, of which the latter may be only a young stage. The dredgings of the United States Coast Survey Steamer "Blake" show that this is quite a common species in the Caribbean Sea to the leeward of the Lesser Antilles.

Station 122. September 10, 1873. Lat. 9° 5′ S. to 9° 10′ S., long. 34° 49′ W. to 34° 53′ W.; 350 fathoms; mud. Off Barra Granda.

Station 24. March 25, 1873. Off Culebra Island; 390 fathoms; mud.

Station 23. March 15, 1873. Off Sombrero Island; 450 fathoms; globigerina ooze.

Station 344. April 3, 1876. Off Ascension Island; 420 fathoms; hard ground.

Station 78. July 10, 1873. Lat. 37° 24′ N., long. 25° 13′ W.; 1000 fathoms; globigerina ooze.

Station 70. June 26, 1873. Lat. 38° 25′ N., long. 35° 50′ W.; 1675 fathoms; globigerina ooze.

Station 73. June 30, 1873. Lat. 38° 30′ N., long. 31° 14′ W.; 1000 fathoms; bottom temperature, 3°·7 C; globigerina ooze.

ARBACIADÆ.

Family Arbaciadæ, Gray, 1855, Proc. Zool. Soc. London.

Arbacia.

Arbacia, Gray, 1835, Proc. Zool. Soc. London.

With the exception of *Arbacia nigra*, the Challenger collected but few specimens of the genus *Arbacia*, so that no material sufficient to undertake a renewed critical examination of the group was obtained. I have already alluded to some of the objections against the view taken by Troschel[1] of the synonymy of several of the species. The specimens of *Arbacia* collected by the Challenger at Valparaiso are undoubtedly the common *Arbacia nigra*; the specimens of *Arbacia dufresnii* collected at Nightingale Island and other localities may, when compared with the specimens of *Arbacia dufresnii* collected in the Straits of Magellan by Dr Cunningham, show how far Troschel is justified in considering *Arbacia alternans* as a distinct species from *Arbacia dufresnii.*

Dr Studer, in his list of Echinids from Kerguelen Island, also distinguishes this species from *A. dufresnii.* Troschel's description is exceedingly minute, but as it is based upon three specimens (one of which is not normal) these differences may after all be only individual differences. I have already, in the Revision of the Echini and the "Hassler" Echini, called attention to the great variability of the characters of the species of this family drawn from the test, such as the number of tubercles, both primary, secondary, and miliary, the ornamentation of the plates of the test, and the outline.

Mr Bell[2] has, in a recent number of the Proceedings of the Zoological Society, called attention to the variation in the number of anal plates, and to the tendency these plates show occasionally, in having less than four plates, to retain the conditions of many young Echinids in their youngest stages of having but a single plate covering the anal system; or, when having more than four plates, to pass into the normal condition of all other regular Echinids of having a large number of plates covering the anal system. This variation is, however, by no means so common as he would have us infer from his statistics. The

[1] Wieg. Archiv, 1873, Die Familien der Echinocidariden.

[2] F. J. Bell, Note on the Number of Anal Plates in *Echinocidaris*, Proc. Zool. Soc. London, May 1879.

following species I have examined with reference to this very point, and find the following results :—

	Number of specimens examined.	4 Anal plates.	5 Anal plates.	7 Anal plates.	8 Anal plates.	13 Anal plates.
Arbacia nigra.						
Callao,	11	11	...	...	...	...
Talcahuano, Chili,	12	11	...	...	...	1
Payta,	9	9	...	...	...	...
Arbacia spatuligera.						
West Coast, South America,	2	2	...	...	...	...
Arbacia pustulosa.						
Naples,	18	18	...	...	...	...
Fayal,	7	7	...	...	...	...
Arbacia dufresnii.						
Straits of Magellan,	6	5	1	...	...	...
Eden Harbour,	8	8	...	...	...	...
Arbacia stellata.						
Payta,	10	10	...	...	...	...
Callao,	4	2	2	...	...	...
Acapulco,	8	6	1	...	1	...
Lower California,	7	7	...	...	...	...
Arbacia punctulata.						
Newport,	10	7	2	1	...	...
Beaufort, North Carolina,	16	16	...	...	...	...
Charleston, South Carolina,	10	10	...	...	...	...
Florida Reefs,	12	12	...	...	...	...

The splitting up of the four anal plates into thirteen columnar plates, as is the case in a large *Arbacia nigra* from Talcahuano, seems due in that case to the increase in growth of the anal plates in a confined anal area. All the specimens which have more than four anal plates are fully grown, and I have not found among the many young of *Arbacia punctulata* I have examined, while working on the chapter on young Echinids for the Revision of the Echini, a single small specimen with less or more than four anal plates. The largest of these young specimens measuring not quite 5 mm. in diameter down to about 1·5 mm. when the young had just resorbed the Pluteus. As I have shown in the Revision of the Echini (p. 734, fig. 68), the young *Arbacia* has already four anal plates in the earliest stages thus far observed.

It will be interesting hereafter to observe the growth of the anal plates of such

genera as *Salmacis, Temnopleurus* and their allies, especially of such forms as *Trigonocidaris*, where the number of anal plates is usually four, and compare it with the growth of the anal system of *Salenia*. I have, fortunately, a number of very young *Saleniæ* dredged in the last "Blake" expedition, and hope in my Report on the Echini of the cruise to return to this subject again.

In none of the specimens of *Podocidaris sculpta* thus far examined (20 +) have I found more than four anal plates.

All the specimens of *Parasalenia* examined (9 +) have four anal plates. Among the smaller specimens of *Cœlopleurus maillardi* collected by the Challenger at Amboyna, of the thirteen specimens examined all had four anal plates. The same was found to be the case in the four large specimens from the Straits of Basilan.

Of the "Blake" specimens of *Cœlopleurus floridanus* I have examined four collected at Barbados and fifteen at Montserrat; they all had only four anal plates.

Arbacia dufresnii.

Echinus Dufresnii, Bl., 1825, Dict. Sc. Nat. O.
Arbacia Dufresnii, Gray, 1835, Proc. Zool. Soc. London.

Nightingale Island; 100 to 150 fathoms.

Station 308. January 5, 1876. Lat. 50° 10′ S., long. 74° 42′ W.; 175 fathoms; mud.

Station 304. December 31, 1875. Lat. 46° 53′ S., long 75° 11′ W.; 45 fathoms; sand.

Arbacia nigra.

Echinus niger, Molin, 1782, Chili (non Rumph).
Arbacia nigra, A. Agassiz, 1863, Bull. Mus. Comp. Zool., vol. i. p. 20.

Gray (1835) did not mention *Echinus nigra* in his list of species belonging to *Arbacia*, though it was evident he intended to do so.[1] In making out my chronological lists (Revision of the Echini), though the species *Echinus nigra* does not appear till 1863 under the name of *Arbacia nigra*, it having then been credited to Gray by mistake, it was accidentally omitted from the list of species, appearing under a new name in A. Agassiz, 1863, Bull. Mus. Comp. Zool., consequently Gray is quoted under *Arbacia nigra* by mistake (Revision of the Echini, p. 401).

Valparaiso shore. November 1875.

Arbacia pustulosa.

Cidaris pustulosa, Leske, 1778, Klein *Add.*
Arbacia pustulosa, Gray, 1835, Proc. Zool. Soc. London.

St Vincent, Cape Verde Islands.

[1] A. Agassiz, 1863, Bull. Mus. Comp. Zool., vol. i.

Podocidaris.

Podocidaris, A. Agassiz, 1869, Bull. Mus. Comp. Zool., vol. i.

**Podocidaris prionigera* (Pl. XXXIV. figs. 14, 15).

Podocidaris prionigera, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 199.

Although *Podocidaris sculpta*, A. Agassiz, was not uncommon in the dredgings of Mr Pourtalès, and in those of the "Blake," yet the Challenger obtained only two specimens of this species. They both differ from the West Indian species, also collected by the Challenger at Station 24, in having a more conical test; the primary spines are not so distinctly limited to the ambitus (Pl. XXXIV. fig. 14) as in *Podocidaris sculpta*, some of the primary tubercles encroaching irregularly upon the test above the ambitus. The test above the primary spines is much more closely packed with small pedicellariæ differing from those figured for *Podocidaris sculpta* in the Revision of the Echini (pl. iv. fig. 15), in having a shorter stem and a stouter head. The large specimen had also a single large tridactyle, pyramidal pedicellaria, with slender valves leaving large openings between them above the base. The arrangement of the miliaries, as we find it in this species of *Podocidaris* (Pl. XXXIV. fig. 14), recalls the somewhat more regular arrangement of the secondaries and milliaries in horizontal rows in some species of *Magnosia* and of *Codiopsis* as does the presence of large primaries near the ambitus or towards the actinostome.

The most characteristic differences, however, between the two species are those of the spines and the structure of the abactinal system. The spines are nearly as long as the diameter of the test, flattened, and comparatively quite slender compared to the broadly lanceolate shaped spines of *Podocidaris sculpta*. The shaft of the spines of *Podocidaris prionigera*, although slightly contracted beyond the milled ring, and a trifle broader at a short distance from it, immediately below that part of the shaft where the marginal serrations commence, yet decreases very gradually in width, tapering more or less rapidly to a point towards the extremity of the shaft. The serrations of the primary spines are prominent, alternating on opposite edges of the flattened shaft; there are not more than twelve on each edge of a spine measuring 10 mm. in length; the serrations commence only at a distance of from one-quarter to one-third the length of the shaft from the milled ring. The spines in alcohol were of a brilliant transparent semi-silvery lustre, with a yellowish-brown basal portion. The test brownish-yellow; it is not ornamented with deep pits in the median interambulacral area as in *Podocidaris sculpta*, and the coronal plates carry above the primary tubercles only the miliaries, irregularly arranged, upon which are supported the short-stemmed large-headed pedicellariæ. The plates of the genital ring (Pl. XXXIV. fig. 15) are arranged much as in *Podocidaris sculpta*, the ocular plates, however, are very much larger than those of *Podocidaris sculpta*; they are elongated vertically, and

extend down towards the ambitus so far that the extremity of the poriferous zone is placed at a point nearly half-way between the anal opening and the ambitus, far below its position in *Podocidaris sculpta*. In both of these specimens the anal system was covered by five plates (Pl. XXXIV. fig. 15) developed equally. The miliaries of the genital plates are larger and more prominent than those of the coronal plates. The madreporic body is but little developed, consisting merely of three to five indistinct pores. In the larger specimen the genital openings are small but sharply defined, and placed excentrically nearer the anal edge, as they are in *Podocidaris sculpta*.

The proportions of the abactinal system are somewhat different in the two species. In *Podocidaris prionigera*, the diameter of the test being 9 mm., the abactinal system is 6 mm., while in *Podocidaris sculpta* it occupies a comparatively small part of the abactinal region (see Revision of the Echini, pl. iv. figs. 6, 8). The actinal system also is comparatively larger in the proportion of 5 to 9 to the diameter of the test; while it is only as 2 to 5 in *Podocidaris sculpta*. On the actinal side the ambulacral suckers are large and powerful; they diminish in size towards the ambitus, and become more distant and pointed as they approach the abactinal system.

Station 218. March 1, 1875. Lat. 2° 33′ S., long. 144° 4′ E.; 1070 fathoms; bottom temperature, 2·1° C.; globigerina ooze.

Station 205. November 13, 1874. Lat. 16° 42′ N., long, 119° 22′ E.; 1050 fathoms; bottom temperature, 2·4° C.; grey ooze.

Podocidaris sculpta.

Podocidaris sculpta, A. Agassiz, 1869, Bull. Mus. Comp. Zool., vol. i.

Station 24. March 25, 1873. Off Culebra Island; 390 fathoms; mud.

Cœlopleurus.

Cœlopleurus, Agassiz, 1840, Cat. Syst. Ectyp.

Cœlopleurus maillardi (Pls. V., VI., XXXVIII. figs. 7–9; Pl. XLV. figs. 1–6).

Keraiaphorus Maillardi, Mich., 1862, Maill. Bourbon. Ann. A.
Cœlopleurus Maillardi, A. Agassiz, 1871, Bull. Mus. Comp. Zool., vol. ii. p. 456.

This remarkable Sea-urchin was first described by Michelin under the name of *Keraiaphorus*. He did not, however, suspect its close affinities to the Arbaciadæ, and Lütken was the first to hint at its identity with *Cœlopleurus*, which a comparison I subsequently made of small specimens dredged by the "Hassler" with Michelin's figures fully corroborates.

The Challenger having collected a number of large specimens (Pl. V. fig. 1) fully equalling in size the original specimen of Michelin, I am now able to clear up many points left doubtful, and to describe at length this interesting Sea-urchin.

On the actinal side the spines are of two kinds both in the ambulacral and interambulacral areas. First, small, slender, more or less cylindrical, pointed, finely serrated, secondary spines (Pl. VI. figs 20*c* and 21*c*) surmount the secondary tubercles intervening between the primary rows, especially on the edge of the interambulacral plates adjoining the poriferous zone; secondly, the primary spines which, near the apical system are scarcely larger than the secondary spines, but are readily distinguished by their triangular or flattened shape, though the ornamentation of the smaller primary radioles is similar to that of the secondaries. As they become large the base of the shaft becomes more finely granular, and the extremity of the spines fluted, with serrated edges; this fluting and serration exists only in the largest primary radioles, and is limited to the part of the shaft included between the milled ring and the shoe. The spines increase very rapidly in size, so that before reaching the ambitus there are in the ambulacral area from four to five, more or less curved, varying in length from nearly the diameter of the test to fully three times as much (Pl. V. fig. 1, Pl. VI. figs. 19*a*, *b*, *c*, 22*a*, *b*, *c*), and two to three of like size on the ambulacral plates near the ambitus. Abnormal as these radioles seem at first glance, the relationship of the genus to the Arbaciadæ gives a very simple explanation of the enormous growth of some of the primary spines. The shaft of the larger primary radioles is composed of two very distinct parts, the basal part, the extension of the shaft beyond the collar, which is triangular, passing into an hexagonally fluted or angular shaft (Pl. VI. fig. 22*a′*, *c′*), finely striated and more or less distinctly covered with minute serrations on the edge of the fluting [which in the shorter primary spines extends to the very tip or near its extremity (Pl. VI. fig. 19*c*)] surmounted by the smooth polished portion of the shaft (Pl. VI. figs. 19*a*, 22*a*, *c*), which is rarely straight, and often very considerably curved, and which sometimes is twice as long as the diameter of the test, and sometimes forms a mere tip to the coloured angular base (Pl. VI. figs. 19*d*, 22*d*). This tip is angular or triangular in younger specimens. As the primary spines pass towards the ambitus they rapidly become shorter, flatter, more slender (Pl. VI. figs. 19*d*, 22*d*), straighter, and immediately around the actinal membrane are reduced again to slender spines, not more powerful than the secondary ones (Pl. VI. figs. 20*c*, 21*c*).

It is the identity of the smaller flattened tipped spines (Pl. VI. figs. 20*b*, 21*b*) around the actinostome with those of other Arbaciadæ which shows plainly that the principal part of the shaft of the radioles of this genus consists of an exaggerated growth of the cap at the tip of the spine so characteristic of the Arbaciadæ and to which Desmoulins (Actes Soc. Lin. de Bordeaux, 1870) first called attention. This cap, however, in the other species of the family is found only on the spines of the actinal surface, and I inferred from the peculiar mode of locomotion of the common

Arbacia of the east coast of the United States that it was intended to replace the wear of the tip of the spines in moving about, a use to which the huge curved spines of this genus, placed as they are above the ambitus, can hardly have been put, unless possibly to raise the test high above the bottom and keep it in suspension; this, however, is probably not a common use of these radioles of the abactinal surface as although slightly worn they are not sufficiently reduced to show extensive usage.

There are no notes with these specimens on their movements after they are brought up in the dredge.[1] We find as in all *Arbaciæ* the round-headed pedicellariæ (Pl. VI. figs. 17, 18) occurring near the abactinal region, while the large-headed, triangular, long-stemmed pedicellariæ (Pl. VI. fig. 16) are found along the test towards the ambitus and more abundantly near the edge of the actinal membrane. The large plates of the actinal membrane are covered by numerous short-stemmed round-headed pedicellariæ (Pl. V. fig. 2). The colour of the base of the shaft of the primary radioles is brownish, of the secondary spines many are of the same colour, but as many are of a brilliant carmine, the white part of the primary shaft, its shoe, is often banded longitudinally with brilliant vermilion or with rectangular spots of the same colour on the upper part of the shaft. In large specimens only here and there a coloured primary spine is found, while in young or smaller specimens the spines are nearly all brilliantly coloured (Pl. V. fig. 3), the glistening white shaft of the large specimens being usually of a delicate pea-green colour, which is well set off by the longitudinal bands or the spots of brilliant vermilion along the shoe, the base of the shaft being a dark greenish-brown or red. In these specimens the short flat spines near the actinal area are frequently banded and spotted like the larger ones. In small specimens the secondary spines are all coloured (Pl. V. fig. 3), and near the abactinal surface they are more or less club-shaped (Pl. VI. figs. 20, 21*d*), much like the rudimentary temporary spines of the abactinal region of the Arbaciadæ, only they are articulated and not soldered to the test as is the case in the other genera of this family.

In a specimen measuring 41 mm. in diameter, the width of the ambulacral system (Pl. VI. fig. 7) near the ambitus is as great as that of the interambulacral. In the former there are twelve primary tubercles increasing rapidly in size from the actinal opening towards the edge of the test, where there follow three to four very prominent tubercles, which are again followed by smaller tubercles rapidly decreasing in size and extending to the genital ring (Pl. VI. figs. 1–3, 5, 7). The scrobicular circles are large, and adjoining primary tubercles are separated in the median ambulacral space by

[1] Quite a number of specimens of *Cœlopleurus floridanus*, A. Agassiz, were dredged during the season of 1878–79 by the "Blake." On placing them in a pail of water I found that they used their large spines as indicated above merely to raise themselves off the bottom when disturbed, using the shorter, stouter tipped spines of the actinal surface for locomotion much as the common *Arbacia pustulosa* of the east coast of the United States. Their movements, however, were much slower than those of *Arbacia pustulosa*, which moves rapidly (see Revision of the Echini). The colour of the West India *Cœlopleurus* is quite well kept in alcohol, and I presume the same is the case for the *Cœlopleurus* collected by the Challenger, which show like the Florida species a great range and beauty of coloration.

few secondary and miliary ones; only in the region near the ambitus and towards the actinal area do the small primaries occupy the whole of the interporiferous zone towards the abactinal region. Near the actinal region in the last four or five plates of the ambulacral area there are, in the angles of the plates along the median line, deep elliptical pits (Pl. VI. fig. 7), of the size of the larger ambulacral pores, in which sphæridia are placed.

In the ambulacral area the tubercles are small, placed upon a prominent boss rising sharply from a broad flat distinct scrobicular area (Pl. VI. fig. 5). The poriferous zone is broad, the pores large, forming more or less distinct arcs of three pairs round the base of the primary tubercles (Pl. VI. fig. 5) near the equatorial region of the test. The pores become smaller, and are placed closer together towards the ambitus (Pl. VI. fig. 7); they are still smaller on the actinal surface. There is no tendency at the very edge of the actinal opening towards the petaloid structure so prominent among other Arbaciadæ (Pl. VI. figs. 3, 7, 8, 10, 11). In the interambulacral spaces there are not more than from seven to eight primary tubercles, corresponding in size, except the last two upper ones (Pl. VI. fig. 6), to the adjoining ambulacral primaries; they are also separated along the median line by a few secondaries and miliaries. On the last five or six interambulacral plates towards the abactinal region there are no primary tubercles, the whole median space is bare (Pl. VI. figs. 1, 2, 6, 9*a*, 13) with the exception of the three or four small secondary tubercles placed near the outer edge of the plates, and which, in the other plates carrying primary tubercles, separate them from the poriferous zone. This bare median interambulacral space is ornamented by a few flat, broad, inconspicuous miliaries, and by smooth broad bands, somewhat raised (Pl. VI. fig. 6), forming irregular S-shaped lines extending from the centre of one plate to the upper edge of the following plate (Pl. V. fig. 1). A brilliant carmine band extends from the genital ring on the inner edge of the secondary tubercles, separating the poriferous zone from the bare space. These secondary tubercles are reduced in number as they approach the genital ring. The genital ring (Pl. VI. fig. 4) is narrow, the anal edge is somewhat raised by a ring formed of broad flat indistinct miliaries, the outer portions of the genital plates being smooth; the genital plates are connected, surrounding the ocular plates which are crescent-shaped, smooth, with one or two diminutive notches, and with a slight hood-like cap over the odd terminal tentacular opening.

The genital openings are large, placed near the outer edge, with the exception of the opening on the madreporic genital which is on the edge of the plate, the madreporic body occupying its central portion (Pl. VI. fig. 4). There are four large smooth anal plates. The genital ring and ocular plates are of a vivid carmine, similar to the vertical interambulacral bands. The actinal notches are not deep, but the grooves formed by the lips for the attachment of the angular prolongation of the actinal membrane covering the passage of the gills are quite prominent (Pl. VI. fig. 7). The principal differences in smaller specimens consist in the proportionally greater width of the

ambulacral system (Pl. VI. figs. 8, 14), the absence or smaller number of the more prominent secondaries and miliaries, the proportionally narrower poriferous zone, the indistinctness of the S-shaped bands of the median interambulacral spaces, the slighter, less deep, actinal cuts, and the comparatively smaller size of the genital openings; these last, as I have shown in the smaller specimens of another species from the West Indies, are perforated quite late. The tentacles of the abactinal part of the test are flattened pouches, pointed at the extremity, resembling those of our common *Arbacia pustulosa*, and evidently, from their size in alcoholic specimens, capable of as great expansion as those of that species figured in Revision of the Echini, pl. v. figs. 1, 2, 6–8.

The pedicellariæ of *Cœlopleurus* agree well in the main with those characteristic of the Arbaciadæ, consisting of the two types, the short-headed, long-stemmed, globular pedicellariæ (Pl. XLV. figs. 3, 4), so characteristic of the abactinal portion of the test in *Podocidaris* and *Arbacia*, and the large-headed ones (Pl. XLV. figs. 1, 2) occurring nearer the ambitus.

Station 201. October 26, 1874. Lat. 7° 3′ N., long. 121° 48′ E.; 82 fathoms and 102 fathoms; stones and gravel.

Amboyna; 100 fathoms. October 8, 1874.

Station 192. September 26, 1874. Lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud.

Diadematidæ.

Family Diadematidæ, Peters, 1853, Monatsb. Akad. Berlin (*emend.*).

Diadema.

Diadema, Schynv., 1711, Thes. Imag. (Peters, *emend.*).

Diadema setosum.

Diadema setosa, Gray, 1825, Ann. Phil. (non Rumph).

St Vincent, Cape Verde Islands.
Cebu, Philippine Islands. January 1875.
Papeete Reef. September 1875.
St Thomas.

**Aspidodiadema.*

Aspidodiadema, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 199.

This is a most interesting genus, intermediate between the Cidaridæ proper and the Diadematidæ. It has like the latter a thin test, with long hollow primary spines nearly straight, and strongly verticillate, especially in the young. The miliary and secondary spines are like the primary radioles, only shorter and proportionally slender (Pl. VIII.

fig. 10). This genus has, like *Centrostephanus,* ten large plates on the buccal membrane (Pl. VIII. figs. 3, 7, 11, 14, 15) carrying miliary spines.

The abactinal system is, as in the Cidaridæ, large and circular, but the genital and ocular plates are uniform in size, and form a narrow ring as in *Glyphocyphus* (Pl. VIII. figs. 4, 13) round the membrane covering, as in the Diadematidæ, the large anal system. In the genital ring of *Centrostephanus rodgersi* two of the ocular plates, those adjoining the madreporic plate, are excluded from the anal system. There are in the ambulacral system, as in *Hemicidaris* and *Salenia,* two vertical rows of large tubercles limited to the ambitus and the actinal system (Pl. VIII. fig. 9), and as in other Diadematidæ the ambulacral system is broad compared to that of the Cidaridæ proper (Pl. VIII. figs. 5, 9). The interambulacral system has, as in *Cidaris* proper, only two vertical rows of large primary tubercles (Pl. VIII. figs. 5, 8). The test is globular, much as in *Amblypneustes.* The most remarkable feature of this genus is the structure of the ambulacral system; the plates composing it are, as in the Cidaridæ, small, arranged in two vertical rows, the plates are nearly of a size, and each plate is perforated by a pair of large pores placed close together (Pl. VIII. fig. 16). The pores are situated on the outside edge of the plates and run in a vertical line (not undulating as in *Cidaris*) from the apex to the actinal system (Pl. VIII. fig. 9). The primary tubercles are perforated and crenulated. The teeth are grooved as in the Cidaridæ and Diadematidæ.

In *Aspidodiadema tonsum* the slender long-headed pedicellariæ (Pl. XLII. fig. 5) are remarkable for the small triangular base of the valve (Pl. XLIV. fig. 15). The globular short-headed abactinal pedicellariæ (Pl. XLII. fig. 4) differ from those of *Aspidodiadema microtuberculatum* (Pl. XLIV. fig. 18); in the latter the valves extend into a stout, rather blunt point with smooth edges, while in *Aspidodiadema tonsum* the short valves are scalloped on the edges and terminate in a powerful hook.

**Aspidodiadema microtuberculatum* (Pl. VIII. figs. 10–16; Pl. XXXVIII. figs. 17, 18; Pl. XLIV. figs. 16–18).

Aspidodiadema microtuberculatum, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 199.

This is a larger species than *Aspidodiadema tonsum* (comp. Pl. VIII. figs. 1 and 10), and is readily distinguished from it by the smaller number of miliary spines covering the test, their irregular size, and by the more numerous, shorter, stouter, dark violet primary spines carried on the interambulacral area. The colour of the test and spines of all the specimens of this species collected by the Challenger was in alcohol of a very dark violet, the same is also the case with the large specimens of *Aspidodiadema* dredged by the "Blake" during the season of 1878–79.

In the median ambulacral spaces there are no large primary tubercles, only small secondary tubercles, nearly of uniform size, placed on the inner angle of the ambulacral

plates (Pl. VIII. fig. 11), forming two median vertical rows; these secondary tubercles are slightly larger near the actinal edge of the test. There are in addition irregular lines of miliary tubercles running transversely near the upper edge of the ambulacral plates parallel with the trend of the pores (Pl. VIII. fig. 16). The primary interambulacral tubercles are perforated and crenulated as in *Aspidodiadema tonsum*. The ambulacral system is separated from the interambulacral area at the actinal area by a slight lip as in the Diadematidae (Pl. VIII. fig. 11). The genital ring is comparatively narrower than in the other species of the genus; the ocular plates are wider than the genital plates, and they are both covered by large, rather distant miliaries. The anal membrane is strengthened by a number of plates forming two irregular rings (Pl. VIII. fig. 13) round the large anal opening; they are covered by short slender diminutive spines. The inner ring is composed of the largest plates. Plate VIII. fig. 15 shows the large size of the ten buccal plates of this species which cover, when denuded, nearly the whole of the actinal membrane. In a specimen measuring 26 mm. in diameter there are eight primary tubercles on the interambulacral plates. In a younger specimen measuring only 10 mm. in diameter there are five primary plates. The ambulacral tentacles are, like those of the Diadematidæ, pointed near the abactinal surface, and carry powerful suckers near the actinostome.

Station 298. November 17, 1875. Lat. 34° 7′ S., long. 73° 56′ W.; 2225 fathoms; bottom temperature, 1·3° C.; grey mud.

Station 299. December 14, 1875. Lat. 33° 31′ S., long. 74° 43′ W.; 2160 fathoms; bottom temperature, 1·1° C.; grey mud.

Station 134. October 14, 1873. Lat. 36° 12′ S., long. 12° 16′ W.; 2025 fathoms; bottom temperature, 1·6° C.; globigerina ooze.

Station 122. September 10, 1873. Lat. 9° 5′ S. to 9° 10′ S., long. 34° 49′ W. to 34° 53′ W.; 356 fathoms.

Off Macio. September 11, 1873. 1700 fathoms.

**Aspidodiadema tonsum* (Pl. VIII. figs. 1–9; Pl. XXXVIII. fig. 19; Pl. XLII. figs. 4–6; Pl. XLIV. fig. 15).

Aspidodiadema tonsum, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 199.

This species is readily recognised by the uniform coating of short, slender miliary spines, which cover the whole test, and by the small number of long slender radioles, some of them nearly three times the diameter of the test, carried upon the interambulacral system (Pl. VIII. figs. 1–3). The genital ring is remarkable for the uniform size of the ocular and genital plates, and the close granulation with which they are covered, with the exception of one or two larger tubercles placed near the anal edge of the plates (Pl. VIII. fig. 4). Immediately round the anal tube there are five large elliptical plates and one

small plate covered with miliaries, and each carrying slender spines, arranged in thick tufts (Pl. VIII. figs. 1, 4, 6), so that in specimens which are not denuded, the whole abactinal system is thickly covered with miliary spines (Pl. VIII. fig. 1). There are in specimens measuring 16 mm. in diameter only eight or nine interambulacral plates, each carrying only one large primary tubercle; the scrobicular area occupies, as in the Cidaridæ, nearly the whole of the plates (Pl. VIII. fig. 5), the rest of the plate being filled with miliaries of uniform size, arranged much as in the Cidaridæ. In the ambulacral system there are from four to five small primary tubercles, increasing in size from the actinostome to the centre of the test, forming two short vertical rows much as in *Hemicidaris*. When alive the colour (in specimens collected by the "Blake") of the miliary spines covering the test is yellowish-pink, the primary spines somewhat darker, or of a light violet tint.

Off Macio; 1700 fathoms. September 11, 1873.

Station 170. July 14, 1874. Lat 29° 45′ S.; long. 178° 11′ W.; 630 fathoms; bottom temperature, 4·0° C.; rocks. Kermadec Islands.

Station 171. July 15, 1874. Lat. 28° 33′ S.; long. 177° 50′ W.; 600 fathoms; bottom temperature, 4·0° C.; rocks.

Off Cebu; 100 fathoms.

Echinothrix.

Echinothrix, Peters, 1853, Monatsb. Akad. Berlin.

Echinothrix calamaris.

Echinus calamaris, Pall. 1774, Spic. Zool.
Echinothrix calamaris, A. Agassiz, 1872, Revis. Ech., part 1, p. 120.

Kandavu Reef. Fiji Islands.
Tahiti Reef.
Cebu Reef.

Echinothrix turcarum.

Diadema turcarum, Schynv., 1711, Thes. Imag.
Echinothrix turcarum, Peters, 1858, Monatsb. Akad. Berlin.

Honolulu.
Kandavu Reef.

* *Micropyga.*

Micropyga, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 200.

This genus, with its flattened test and short spines, is closely allied to *Astropyga*, from which it mainly differs in the small size and the structure of the abactinal system, which

resembles more that of *Centrostephanus* and *Aspidodiadema*, and in the greater rigidity of the test, as in *Diadema*; the bare sunken median interambulacral space extending from the apical system towards the ambitus, so characteristic of *Astropyga*, is in this genus narrow; it bears, as in *Astropyga*, small primary tubercles, forming two vertical rows along the median ambulacral line. The primary tubercles of the interambulacral areas above the ambitus are placed in the centre of the plates, and arranged in one principal vertical row, with irregular rows of smaller secondary tubercles. As in *Astropyga* the actinal floor is thickly covered with large primary tubercles, deep actinal cuts are present, the poriferous zone is narrow, the pores are in pairs arranged in two vertical rows, the spines of the abactinal surface are short and slender like those of *Astropyga* proper, while on the actinal side they are more or less club-shaped, or trumpet-shaped, resembling somewhat the actinal spines of *Asthenosoma* and *Phormosoma* (but they are not tipped with a hoof as in some species of these genera), with which both this genus and *Astropyga* have many points in common, forming a connection as it were between the Diadematidæ proper and the Echinothuridæ. The primary and secondary tubercles are perforate, but not crenulate. The primary and secondary ambulacral and interambulacral radioles are similar in structure, with exceedingly fine verticillations, forming in older specimens a delicate longitudinal striation.

In *Micropyga* the long-headed pedicellariæ closely resemble those of the Diadematidæ.

**Micropyga tuberculata* (Pls. VII., XXXIX. figs. 1, 2; Pl. XL. figs. 26–28; Pl. XLIV. fig. 37).

Micropyga tuberculata, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 200.

This is a large species, measuring no less than 200 mm. in diameter, the actinal surface is flat (Pl. VII. fig. 2), the ambitus making a sharp angle with it, and the test is regularly arched towards the low flattened abactinal surface. On the actinal interambulacral spaces the primary tubercles are arranged in a single horizontal row, occupying, with the exception of a few miliaries, the whole of the coronal plate, they form a close pavement (Pl. VII. figs. 2, 4), and increase uniformly in size from the actinal edge to the ambitus, making more or less irregular vertical rows, radiating from the actinostome, there being from six to seven rows at the ambitus. In the ambulacral areas the primary tubercles, arranged in only two vertical rows, increase regularly in size towards the ambitus (Pl. VII. figs. 2, 4), where they as well as the interambulacral tubercles are largest, and while occupying there nearly the whole of the ambulacral plates between the poriferous zone, become reduced on the abactinal surface to small secondary tubercles placed in the centre of the ambulacral plates, which carry, besides, a few small miliaries or granules, occurring irregularly on the plates (Pl. VII. fig. 1, 7). The same rapid change takes place in the size of the primary tubercles of the interambulacral areas of the abactinal surface (Pl. VII. fig. 1);

immediately past the ambitus the primaries are reduced to a single vertical row of a much smaller size than those of the actinal surface, placed in the central part of the coronal plates and extending nearly of uniform size to the abactinal system. The rest of the plate (Pl. VII. fig. 5) carries a few secondary tubercles and miliaries irregularly arranged, the former forming indistinct vertical rows, the latter indistinct horizontal lines. The poriferous zone is of nearly uniform width, from the actinal edge to the apical system. The actinal cuts (Pl. VII. fig. 3) encroach deeply upon the interambulacral plates; there is no tendency to expansion of the poriferous zone at the actinostome The bare median interambulacral spaces (Pl. VII. fig. 1) as seen from above are ill-defined, and have not the prominence they take in *Astropyga*. The pedicellariæ of the lower surface are narrow-headed, elongate, with a long stem; they are similar in the ambulacral and interambulacral areas of the actinal and abactinal sides. The apical system (Pl. VII. fig. 6) is characterised by the small anal system covered with numerous irregularly-shaped plates, carrying few miliaries near the genital edge. The genital plates are uniform in size, pentagonal, with rounded points; the genital openings are large, and are placed near the pointed extremity as in the Diadematidæ. The madreporic body is not prominent, the ocular plates are hexagonal, they carry five to seven miliaries irregularly placed like those of the genital plates near the anal edge.

In younger specimens (Pl. VII. figs. 7–9) the principal differences consist in the comparatively larger size of the primary tubercles of the abactinal region, their smaller number on the actinal surface and the larger size of the plates covering the anal system. The genital plates are less elongated, the ocular and genital plates resembling at this early stage in their arrangement that of the genital ring of *Aspidodiadema*. A young specimen measuring 26 mm. in diameter shows that in this species the changes due to growth are readily traced; they consist in the smaller number of coronal plates and the smaller number of the primary and secondary tubercles, but their ultimate arrangement is already indicated in this smaller specimen. The spines are, however, proportionally much longer, equalling in length nearly one-half the diameter of the test. The spines in this specimen are still white, only a few contain a slight trace of light violet pigment matter tinting the extremity of the spines or forming irregular patches or transverse bands on the spines. The imbricating plates of the actinal membrane are very distinct. The difference in size between the genital and ocular plates of the anal ring is hardly appreciable, it was already quite small in that of the young specimen figured on Plate VII. fig. 9.

In large specimens the colour of the test in alcohol is a dark violet, the spines of a dark violet brown.

Station 174. August 3, 1874. Lat. 19° 10′ S., long. 178° 10′ E.; no fathoms on label. Text. 255, 610, and 210 fathoms; bottom temperature at 600 fathoms, 3·7° C.; globigerina ooze.

Station 219. March 10, 1875. Lat. 1° 50′ S., long. 146° 42′ E., 150 fathoms; mud.

Off Cebu; 100 fathoms. January 22, 1875.

Station 204. November 2, 1874. Lat. 12° 43′ N., long. 122° 10′ E.; 100 fathoms and 115 fathoms; mud.

Astropyga.

Astropyga, Gray, 1825, Ann. Phil.

Astropyga pulvinata.

Cidarites pulvinata, Lamk., 1816, Anim. sans. Vert.
Astropyga pulvinata, Agassiz, 1846, C. R. Ann. Sc. Nat., vol. vi.

In a young specimen of this species measuring only 19 mm. in diameter, the small size of the actinostome, 5·5 mm., is quite exceptional, as one of the principal features which distinguishes the old specimens of *Astropyga pulvinata* from *Astropyga radiata* is the proportionally large actinostome; the tubercles of the actinal surface are in this small specimen of quite uniform size in both areas, near the actinostome the large primaries appearing only near the ambitus. On the abactinal side the special features to be noticed are the crowding of the small ambulacral tubercles in the upper part of the zone and the existence of a very prominent vertical row of large primary interambulacral tubercles flanking the poriferous zone and extending well towards the abactinal area. The bare median interambulacral spaces extending from the abactinal area are well defined, and the large bright violet spots existing on each coronal plate on the outer edge of this bare area extend to the ambitus. The anal tube of this young specimen is, as in all young Diadematidæ, long, and rises prominently above the anal system. On comparing this small specimen with two smaller specimens of *Astropyga radiata* collected at the Philippines by Dr Semper we can at once distinguish the young of the two species by the different aspect of the actinal surface, which in the young of *Astropyga radiata* is somewhat convex without presenting the close uniform tuberculation of that of the young of *Astropyga pulvinata.* In the specimen of *Astropyga radiata*, measuring 15 mm. in diameter, the actinal opening measured 6 mm. In the other, measuring 12·5 mm., the actinal opening was nearly 6 mm. or larger than in the young of *Astropyga pulvinata*, measuring 19 mm. in diameter. The pentagonal outline already noticed in a small specimen of *Astropyga radiata*, measuring 36 mm. in diameter, becomes more prominent in the smaller specimens measuring 15 mm. and 12·5 mm. in diameter. It is very evident from the above that in both these species we have considerable variation in some of the characters which have thus far been employed to distinguish the two species.

Unfortunately the series of specimens at my command are not such that a comparison can be made of corresponding stages of the two species

Station 190. September 12, 1874. Lat. 8° 56′ S., long. 136° 5′ E; 49 fathoms; bottom temperature, 23·9° C.; mud.

Station 188. September 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E.; 28 fathoms; mud.
Honolulu; 18 fathoms. July 30, 1874.

ECHINOTHURIDÆ.

Family ECHINOTHURIDÆ, Wyville Thomson, Depths of the Sea, 1873, p. 164.
Wyville Thomson, 1874, Echinoidea of the "Porcupine," Trans. Roy. Soc., vol. clxiv. part 2, p. 730.

The characteristic overlapping of the ambulacral coronal plates has been well described and figured by Thomson (Echinoidea of the "Porcupine," Trans. Roy. Soc., vol. clxiv. part 2, p. 730, pl. lxv. and following; see also A. Agassiz, Revision of the Echini, pl. ii.[c]). I have here given some additional details mainly regarding *Phormosoma*, and have also called attention to the changes in the family characters due to growth.

Thomson speaks, in the Depths of the Sea, of the vermicular movements passing through the test of *Asthenosoma*, when it assumed on deck what appeared to be its normal form and attitude. When handled, the test moved and shrank from the touch, and had much the feeling of the disk of a *Solaster* or other large Starfish. I have in one of my letters to the Superintendent of the U. S. Coast Survey[1] spoken of the globular form of the species of *Asthenosoma* when they came up in the trawl, but I can only corroborate the statements of Thomson regarding the peculiar movements of the test of specimens when on deck, due undoubtedly to the great mobility of the plates of the test. It is quite dangerous to handle these specimens when alive (or even in spirits); the wounds they made with their numerous minute sharp stinging spines producing a decidedly unpleasant sensation, accompanied with a slight numbness, fully as painful as that occasioned by the stinging of a *Physalia*.

Some of the species of Echinothuridæ here described, show that some of the important characters upon which this family is distinguished from the Diadematidæ may become gradually obliterated, and the existence of such species as *Phormosoma asterias*, *Asthenosoma gracile*, and *Phormosoma rigidum*, where the lapping of the plates is reduced to a minimum, if it exists at all, and where, as in all the young of the group, the distinction between the actinal and abactinal surfaces, so striking in the larger specimens, does not exist, and develops only with increasing size, show how difficult it is to separate this group of Echinids as a distinct family from the Diadematidæ.

The lapping of the coronal plates in the Echinothuridæ is not so absolutely a characteristic feature of the family as has been supposed. It exists already well-developed in *Astropyga* (Pl. X.[c] fig. 9), but with this important difference, that the overlapping of the plates is in the same direction in both areas. The lower edge of the plate passes under the upper edge of the preceding plate. In *Echinothrix* and *Diadema* also, the shape

[1] Letter No. 3, Bull. Mus. Comp. Zool., vol. v., 1879.

of the coronal plates is already markedly pistol-shaped, the sutures do not extend horizontally, or nearly so from one area to the other as they do in the other Desmosticha, and we can trace a slight bevel in the same direction as that of *Astropyga* in a section of the junction of adjoining coronal plates. In *Astropyga* the plates being narrower and more elongated, and, consequently, more numerous, the pistol shape of the coronal plates is very striking, and is as fully developed as in some stages of *Asthenosoma*, lapping slightly along the median line. Another very characteristic feature of the Echinothuridæ we also find in *Astropyga*. I have called attention to the splitting up of the interambulacral plates into irregularly shaped independent plates, thus producing interambulacral areas which, as in the Palæechinidæ proper, are composed of more than two vertical rows of plates. The fact that there are more than two vertical rows in the ambulacral areas in the Desmosticha as well as Palæechinidæ I have referred to on a former occasion. In *Astropyga* we find that the large interambulacral plates from the edge of the ambitus nearly to the abactinal system, as far as the external line of primary tubercles extends, are made up of two very distinct plates (Pl. X.[a] fig. 9), so that in *Astropyga* as well as in *Phormosoma* we have an interambulacral area in which the vertical zones are not composed simply of two rows of plates but of four, and in which the primary tubercles of the actinal surface recall very strikingly from their deeply sunken areolæ, those of *Archæocidaris* and *Phormosoma*. *Astropyga* must therefore be considered a genus either belonging to the Echinothuridæ, or at any rate possessing some of the most characteristic features of both the Diadematidæ and Echinothuridæ. The interambulacral plates of the actinal surface of *Astropyga* differ from those of *Phormosoma* in which the primary tubercles are deeply sunken; but when seen from the interior, the deep hollow primary tubercles of the genus connect the solid tubercles of *Echinothrix* and *Diadema* with the hollow and deeply sunken tubercles of *Phormosoma* proper. The shorter and somewhat club-shaped spines of the actinal surface, like those of *Micropyga*, resemble somewhat the shorter hollow-tipped spines of the actinal surface of the Echinothuridæ.

In most of the Desmosticha with spherical tests a certain amount of bevelling occurs in the joints of adjoining plates, this bevelling corresponding more or less to the curvature of the test; and when there are a large number of plates in a thin test, the edges appear parallel, while the direction of the joints is readily traced in genera having few coronal plates and a comparatively thick test. In *Echinarachnius* the upper edge of the plates of the ambulacral system within the petals is inclined towards the abactinal system. It certainly seems impracticable to base a classification of the Echinoidea on this character of the imbrication or abutting of the coronal plates in the different groups of Echinids as has been proposed by Keeping.[1]

Both in the Cidaridæ and in the Echinothuridæ in which the imbricating plates of

[1] Palæozoic Echini, Quar. Jour. Geol. Soc. London, 1876, vol. xxxii. p. 40.

the actinal membrane are pierced for the passage of ambulacral tentacles, new plates for this membrane are formed by becoming detached from the ambulacral zones. It is readily seen on examining a large *Asthenosoma* how the small ambulacral plates of the poriferous zone become isolated and gradually increase in size laterally, until they eventually meet the corresponding plates from the adjoining ambulacral zones; and thus, in spite of the increasing size of the actinal opening with advancing age, it is kept covered by the newly-formed plates detached from the edge of the test at the point of contact with the actinal membrane. These plates extend on one side towards the median line of the ambulacral zone, and in the other direction meet on the median line of the interambulacral zone. In the younger stages there are plates in the extension of both the ambulacral and interambulacral areas.

Lovén and Ludwig have shown that the imbrications of the plates so characteristic of the Palæozoic Echinoidea is not completely lost, even in Spatangoids; and from the peculiar mode of growth of the plates, regularly concentric round a nucleus, a thinner edge is formed, which maintains by its encroachment on adjoining plates a considerable degree of mobility in the tests of the globular Spatangoids during their growth. And when we go back to the very earliest stages of growth of the plates composing the test of Echinids, when they are made up of mere Y-shaped rods, we can readily see that the lapping of the coronal plates is a feature very characteristic of all Echinoid structures from the very nature of the basis of the calcareous plates composing the test; whether it be in a Palæozoic *Echinus*, a *Cidaris*, a Spatangoid even, or a Crinoid, a Starfish, or a Holothurian, it is found occurring in all the plates.

The gills pass as in the Diadematidæ proper between the edge of the plates of the test proper and the imbricating plates of the actinal membrane, though the openings through which they pass can scarcely be called cuts; they are small indentations, the result of the space left between the curved edge of the last interambulacral plate, and the next plate of the actinal membrane, or of the notch formed by the overlapping of the extremity of the last plate over the side of the next coronal plate. The gills appear at a very early stage; in the youngest specimens, they are mere digits, or a simple fork in the smallest specimens I have examined. The gills become quite prominent in some of the species (see Pl. XIX.[a] fig. 1, *Asthenosoma tessellatum*). New plates of the anal system, on the contrary, appear to form next to the anal opening, and are gradually pushed away towards the genital plates, though evidently additional plates are also formed by the splitting of the older and larger plates, especially those adjoining the abactinal extremity of the interambulacral area.

Judging from the large size of the genital openings and the large size of the eggs in one of the species, this group of Sea-urchins is probably viviparous; and we find here also, in the great distance at which the genital openings are placed from the anal system, some-

thing of the same structure which ends in some of the Clypeastroids in the genital openings being placed outside the genital plates.

We find that it is in the older groups, such as the Cidaridæ and Salenidæ, that the ocular plates attain their greatest development, less marked, as Lovén has pointed out, among the Spatangoids and still less conspicuous in that most recently developed of all Echinoid types, the Clypeastroids. As far as the genital plates are concerned they are by no means always connected with the genital pores, as the ocular pore is invariably connected with its plate. The genital opening has no such morphological significance in its relation to the test as the ocular pore, and is in the first place not developed in young Echinids; and furthermore these plates form a part of the coronal system at that time, and the openings of the genital system may be placed in the interambulacral area entirely outside of the genital ring, as is the case among many of the Clypeastroids, and even, as I have shown in the viviparous Cidaridæ, the greater part of the genital openings are not placed in the genital ring, thus clearly showing the want of connection between the so-called genital plates and the external opening of the genital organs in genera in which these plates attain their greatest development and in which they retain their normal shape even in the adult.

The young specimens of *Phormosoma* and *Asthenosoma*, figured on Plates XII.[a], XVIII., XVIII.[c], show some interesting points in the development of the abactinal system of the poriferous zone, of the actinal surface, and of the structure of the coronal plates, which throw considerable light on the affinities of the Echinothuridæ to other groups of the Echinoidea. I have already in the Revision of the Echini (pl. ii.[c] figs. 1, 2) figured a very small *Asthenosoma hystrix* (3·1 mm. in diameter), and called attention to the rudimentary separation between the plates of the ambulacral and interambulacral areas, to the absence of a regular abactinal system, and also of an imbricating actinal membrane. In the smallest specimen of *Phormosoma* collected by the Challenger (*Phormosoma uranus*) (Pl. XVIII.[c] fig. 12), measuring 8 mm. in diameter, the actinal membrane was already covered with plates, but plates differing in their arrangement from those of the adult, and presenting features which associate these young stages far more with the Diadematidæ proper than with the Echinothuridæ.

The actinal membrane has, as in *Centrostephanus* and *Echinothrix*, ten large buccal plates, forming a nearly closed ring round the actinostome, with an outer ring of twenty plates, ten ambulacral perforated for tentacles, and ten interambulacral plates. This same structure is still seen in a young specimen of *Phormosoma tenue* (Pl. XVIII.[c] fig. 7), measuring no less than 49 mm. in diameter, while in a specimen of *Asthenosoma gracile ?* (Pl. XII.[a] fig. 6), measuring 24 mm. in diameter, the imbricating plates are already well developed, but have not as yet united with the adjoining interambulacral plates as they do in the adult. The same is the case in a young *Phormosoma luculentum*, measuring 36 mm. in diameter (Pl. XVIII.[c] fig. 4). In this stage the young Echino-

thuridæ closely resemble what I have temporarily regarded as the young of *Micropyga tuberculata* (Pl. XVIII.[c] figs. 10, 11; Pl. VI.[a] figs. 6, 7). We find there the actinal membrane carrying ten buccal plates, with other plates in the extension of both the ambulacral and interambulacral areas (Pl. VI.[a] fig. 7), but only the buccal plates and the two ambulacral plates adjoining the test are perforated for tentacles, while in the young of *Phormosoma*, with a corresponding stage of development of the actinal membrane, the ambulacral actinal plates are all perforated. In the young of *Micropyga* (Pl. VII.[a] fig. 6) the apical system at an early stage shows the structure characteristic of the genus, while the anal system is left comparatively bare of plates. This is not the case with the apical system of the young of *Phormosoma* or of *Asthenosoma*. The anal system (Pl. XVIII.[c] figs. 2, 5, 6; Pl. XII.[a] figs. 2, 5, 7) is at an early stage covered by a large number of distinct plates, while the genital ring of corresponding stages is, on the contrary, often quite indistinct from the anal plates (see Pl. XVIII.[c] fig. 6); while in other cases (Pl. XII.[a] figs. 5, 7; Pl. XVIII.[c] fig. 3) the genital and ocular plates are more distinct perhaps from the anal system than they are in older stages, especially in those species where the genital plates show a tendency to split up into distinct plates, the upper plates apparently belonging to the anal system, or where the genital plates encroach far into the median interambulacral space[1] at the abactinal extremity of the test, separating completely the adjoining interambulacral plates. So that, judging from the few young Echinothuridæ which have been examined, the new plates of the actinal membrane are primarily formed by becoming separated from the ambulacral plates of the test, while additional interambulacral plates seem to be formed at the abactinal pole from the pushing down of large marginal plates of the anal system on each side of the genital plate.

This whole development of the abactinal and actinal systems of the Echinothuridæ and Diadematidæ, plainly shows a far closer structural relationship between them and the coronal plates than is apparent when studying the regular Desmosticha, in which the contrast between the compact abactinal system, and the nearly bare actinal membrane with the coronal plates is most apparent. In fact, the structure of the apical and actinal systems of the Spatangoids and Clypeastroids shows the close connection existing between them and the coronal plates, and also plainly shows that both these systems are but modifications of the actinal and abactinal extremities of the coronal plates, as is more plainly seen to be the case in the Starfishes and Ophiurans and in the Holothurians, where the coronal plates are reduced to their simplest expression.

The coronal plates of the youngest specimens of *Phormosoma* (Pl. XVIII.[c] figs.

[1] See the great extension of one of the genital plates in *Heterodiadema libycum* of Cotteau. This was supposed to have been the anal opening. In Cotteau's figure (pl. xv., 5 fasc., Echin. Algérie) it is clear that it enters, as in the Echinothuridæ, deeply into the interambulacral spaces, but not all, only into one on account of the inequality in size of the genital plates.

1, 2, 5, 12) and *Asthenosoma* show but the slighest possible trace of the lapping of the edge of the plates of the ambulacral and interambulacral areas.

It is only in somewhat older stages (Pl. XII.[a] figs. 4, 5; Pls. XVIII., XVIII.[c] figs. 3, 6, 7) that the lapping of the sutures becomes apparent, or that the interstices between the plates are formed; unfortunately there are not among the Challenger specimens enough small specimens to enable me to open a sufficient number of stages to examine the changes in the imbrication of the plates due to growth.

There are, however, among the Echinids of the last "Blake" expedition a large number of young stages both of *Phormosoma* and *Asthenosoma*, and I hope to return to this subject in my final report on the "Blake" Echinoidea.

On the abactinal surface the arrangement of the tubercles characteristic of the adult seems to be developed at a comparatively early stage (see young of *Asthenosoma pellucidum*, Pl. XVIII. of *Phormosoma tenue*, and *Phormosoma luculentum*, Pl. XVIII.[c]), and the same is the case with the characteristic features in the great development of the primary tubercles of the actinal surface (see Pl. XVIII. figs. 1, 4, 8, and Pl. XVIII.[c] figs. 4, 7).

The irregularity of the course of the poriferous zone on the actinal surface is not characteristic of the adult alone. In the earliest stages of *Phormosoma*, which I have thus far examined (Pl. XVIII.[c] figs. 4, 7; Pl. XII.[a] figs. 3, 6, 8), the same irregularity already exists, the poriferous zone extending in a straggling line of pores from the ambitus to the actinal membrane. The poriferous zone of the abactinal surface in the young stages is also narrower than in the adult and is confined mainly to the outer edge of the ambulacral area, extending in a more or less irregular undulating zigzag line of pairs of pores from the ambitus to the abactinal system (Pl. XII.[a] figs. 4, 5, 9; Pl. XVIII.[c] fig. 6), and the pores attain only in later stages the characteristic arrangement of the adult.

In the young *Phormosoma* the small intercalated plate of the poriferous zone is not placed as it is in the adult about halfway between the outer edge of the ambulacral zone and the median line, but is found close to the outer edge, gradually passing with increasing age and size towards its more central position (Pls. XVII. and XVIII.).

Although in one of the species (*Phormosoma luculentum*, Pl. XVIII.[c] fig. 3) the definite arrangement of the pores characteristic of that species was already perceptible in a specimen measuring not more than 36 mm. in diameter, the alternate arrangement of the poriferous zone seems to be attained earlier in *Phormosoma* than in *Asthenosoma* (see Pl. XVIII.); though in a young *Asthenosoma* (*A. gracile?*), measuring 30 mm. in diameter, the poriferous zone was already separated into its two components much as in the adult.

In all the young Echinothuridæ in which the imbricating membrane of the actinal surface was partly developed, the gills are already present, though in the early stages they appear as simple diminutive forks, and soon increase in size to form somewhat more fan-shaped appendages, with three to four short digits (Pl. XII.[a] fig. 6, Pl. XVIII.[c] fig. 4, 7); but in the young as in the old, even when highly developed, as in *Asthenosoma tessellatum*,

the gills do not pass through cuts in the test so prominent in the Diadematidæ, but force their way through the membranous space between the coronal plates and the actinal membrane proper at the angle of the poriferous zone and interambulacral area.

The discovery of recent Echinothuridæ has naturally led to a renewed discussion of their affinities with the Palæechinidæ and other Palæozoic Echinids, and more particularly of the systematic relations of the Palæechinidæ to the Desmosticha. The relationship to the Cidaridæ and Echinothuridæ is certainly not very remote, as will be seen when we come to compare the apical and actinal systems of the Cidaridæ with those of the Palæechinidæ, and the structure of the primary tubercles of the actinal surface of the recent Echinothuridæ to the primary actinal plates of *Archæocidaris* and *Eocidaris*.

As far back as 1857 Müller[1] called attention to the imbricating plates of the test, not only of *Lepidocentrus* but also of *Archæocidaris*, and both Lovén[2] and myself called attention to the imbrication of the coronal plates of the Perischoechinidæ as a general character of the group. In 1874[3] I called attention to the fact that Müller's observation had escaped the attention of the American Palæontologists, to whom we owe the description of so many of the genera of this interesting group of Echinids. Later English writers[4] on the subject, who have, in consequence of the discovery of the recent genera *Asthenosoma* and *Phormosoma* with the imbricating coronal plates, taken up the question again seem likewise to have completely overlooked what Müller had published on the subject.

There are in the collection of the Museum of Comparative Zoölogy a number of specimens of Palæechinidæ, which with the fine collection of Palæechinidæ from the Burlington limestone made by Mr Wachsmuth, which he has been kind enough to lend me for inspection, has enabled me to examine the greater number of the genera thus far described, and to satisfy myself, from personal examination, of the structure of the coronal plates of the Perischoechinidæ.

As has been pointed out by Etheridge[5] there are two very distinct types among the Palæechinidæ. Those in which, as in *Lepidesthes, Lepidechinus, Echinocystites, Lepidocentrus*, and the like, we have comparatively thin coronal plates imbricating like the tiles of a roof both towards the actinal and abactinal region as well as laterally, and those in which, as in *Oligoporus, Palæechinus*, and *Melonites*, the coronal plates are of great thickness and on which the plates abut by more or less bevelled edges but still retain the same lateral and vertical (actinal or abactinal) direction. This division, of course, depends entirely upon the thickness of the plates of the test, and is not based upon important structural features, though the facies of such genera as *Oligoporus* and *Lepidesthes* would at the first

[1] J. Müller, Ueber neue Echinodermen des Eifeler Kalkes, Berlin, 1857; Abhand, d. Berlin Akad. für 1856.
[2] S. Lovén, Études sur les Echinoïdées.
[3] Revision of the Echini, part 4.
[4] J. Young, Geological Magazine, vol. x. p. 301, 1873; W. Keeping, Quar. Jour. Geol. Soc., vol. xxxii. p. 35, 1876.
[5] R. Etheridge, Jr., Quar. Jour. Geol. Soc., 1874, vol. xxx. p. 307.

glance appear to indicate very widely differing structural characters. In the same way, widely separated as *Archæocidaris* and *Oligoporus* appear, the existence of such genera as *Lepidocentrus*, and *Pholidocidaris*, shows that even the characters which at first sight so strongly contrast in *Melonites* and *Archæocidaris* may gradually disappear, although undoubtedly the type to which *Melonites*, *Oligoporus*, *Palæechinus*, and the like belong would lead us more directly as far as the structure of the coronal plates is concerned to the abutting plates of the Echinids of the present period, which as I have attempted to show are really all to a certain extent bevelled at the edges. This bevelling depends first upon the curve of the test and in the second place upon the thickness of the test, while such decidedly imbricating coronal plates as those occupying the actinal surface of the test in *Archæocidaris* and the like, and on which we find also a single large primary tubercle developed, lead us directly to the Echinothuridæ, and to such types as *Phormosoma*, which are evidently not very different in their structure from the Silurian *Archæocidaris;* and at the present day the Diadematidæ, especially *Astropyga*, still retain traces of the existence of more than two rows of interambulacral plates and of the imbrication of the coronal plates, within the ambulacral and interambulacral areas, so prominently developed in the Echinothuridæ of the present day. This is not the only family in which we find interambulacral areas with more than two rows of coronal plates. In the remarkable genus *Tetracidaris* of Cotteau, the double row of interambulacral plates on each side of the median line is not limited as in *Astropyga* to a few plates on the actinal sides of the test. In that genus we find only a short part of the interambulacral area near the abactinal part of the test where the normal number of interambulacral plates are present, while in the rest of the test, with the exception of the few plates near the apical system, the interambulacral areas consist of four rows of primary plates.

The very peculiar splitting of the vertical rows of coronal plates noticed by Quenstedt in *Melonites*[1] seems to point to some structural peculiarity in the Palæechinidæ such as I have described in the breaking up of a single interambulacral plate in our recent Echinothuridæ. It shows, at any rate, what some of the other genera of Palæechinidæ plainly show, that we find it impossible to define the number of rows of coronal plates in the test just as we find it impracticable near the apical system of the regular Echinids to ascertain how many rows of interambulacral plates there are present, as they appear in that region of the test packed in as they best can find place and take up their regular and symmetrical arrangement only later, while we may observe that in the Palæechinidæ this symmetrical arrangement never takes place, the vertical rows of plates running in as best they can, thus forming another important embryonic character of the Palæechinidæ.

From an embryological and palæontological standpoint perhaps no more important view has been taken than that of Lovén regarding the nature of the apical system of the Echinidæ, which he developed from a comparison I had at first indicated of the complete

[1] Quenstedt, Pal. Deutsch., 1872 to 1875, vol. iii. p. 381.

analogy of the plates of the young Starfish to those of the Crinoids, and which he has most suggestively extended to the Echinids, and which most naturally explains the great number of plates we find both on the ambulacral and interambulacral plates of the Palæechinidæ, in which as in the Crinoids the plates composing the calyx subdivide into numerous joints or into numerous plates to form the test of our oldest known Sea-urchins, which thus still show most unmistakably their systematic affinity to the Crinoids.

Unfortunately, in the types with thin coronal plates (*Eocidaris*, *Archæocidaris*, &c.), owing to the loose cuticle by which these plates were probably connected, much as we find them in the modern Echinothuridæ, it is not probable that we shall find whole tests, as even in the recent types when they are dried the plates readily become disconnected, and we can form no idea of their shape when alive even from well-preserved alcoholic specimens. The abactinal system especially of these genera will very rarely be well preserved, and we can only from analogy with the recent types form an idea of the principal structural features of that part of the test. The plates of the actinal system generally hold together more firmly, and from the similarity of its structure in such genera as *Archæocidaris*, *Pholidocidaris*, and *Lepidesthes*, we can fairly assume that the abactinal system corresponds in its general features with that of the Echinothuridæ. As far as I can judge from the specimens of Palæechinidæ in my possession which have retained any part of the actinal region of the test adjoining the actinostome, we find that in *Lepidocentrus* there is no distinct line of division separating the coronal interambulacral plates from those belonging to the actinal membrane. The ambulacral plates are continued in a remarkably well-preserved specimen from the lower Burlington Limestone to the very teeth, and the same is the case with the interambulacral plates; neither the ambulacral nor the interambulacral plates show any line of demarcation such as we still find in the Cidaridae or such an indistinct one as exists in the recent Echinothuridæ, and as far as I could see in the specimen referred to, the test of this genus was evidently composed of entirely similar plates, extending from the edge of the actinostome, from the very membrane which was attached to the teeth to the abactinal system, that is, the coronal plates extended from the actinostome without the usual subdivision of the actinal membrane into ambulacral and interambulacral plates which in this genus at least did not exist. In fact this genus corresponds exactly to a stage of the Cidaridæ in which the coronal plates as they are developed in that family should be reduced to a minimum and replaced by the extension over the whole test of imbricating plates, such as still exist prominently developed in the Cidaridæ, and to a more limited extent in some other Echinids, on the actinal membrane. In the Cidaridæ proper the junction of these plates with the coronal plates is still quite well marked, while in the recent Echinothuridæ the distinction between them is much less apparent. As regards the actinal system of *Melonites*, from what we know of its structure from Meek and Worthen, it apparently belonged to the same type as that of *Lepidocentrus*.

The abactinal system of *Melonites*, on the contrary, from the drawings of Rœmer and of Meek and Worthen, and of *Palæechinus* from those of Bailey, resembled far more that of the Cidaridæ proper than of the recent Echinothuridæ. The ocular and genital plates are comparatively large, in striking contrast to the adjoining minute ambulacral and interambulacral plates of the abactinal region of the test, forming a most distinct line of division between the so-called coronal plates and the plates of the abactinal system. This is somewhat remarkable, as the plates of the abactinal system are evidently, from what we know of their appearance in young Echinids, developed comparatively later than the coronal plates.

In *Lepidocentrus* and in *Archæocidaris*, on the contrary, the plates of the abactinal system resemble far more in their size and arrangement those of the abactinal system of the recent Echinothuridæ. In *Lepidocentrus*, for instance, the genital plates bear about the same proportion to the plates of the anal system which we find in some of the recent Echinothuridæ, and there exists at the apical extremity of the coronal plates the same difficulty in defining where the interambulacral plates terminate and the plates of the apical system begin.

The existence of double pores in the apical system does not seem to indicate in the Palæechinidæ an abnormal structure among Echinoidea. Lovén has already shown how in the Arbaciadæ the ocular pore is divided into two, and we must remember that in the Spatangoids it is the contrary process which takes place, in the passage of double pores to simple pores and then to double pores again between the actinostome and the abactinal system. It seems to me to be merely the first indication of the subsequent subdivision of the ambulacral pores to be traced among the Echinoidea which becomes so universal among the regular Echinids, though it is transferred to a different part of the poriferous zone, while in many Spatangoids it is limited to special portions of the poriferous zone. In the Palæechinidæ we may consider this the first indication probably of the specialisation of any one of the ambulacral tentacles.

In a specimen of *Archæocidaris* from the Keokuk Limestone showing the actinal side of the test, the actinal plates immediately adjoining the actinostome are small imbricating plates, forming a somewhat indistinct line of demarcation with the true coronal plates quite as clearly defined as in the recent Echinothuridæ when compared to the primary coronal plates surmounted by a single large primary tubercle as in *Phormosoma*. The ambulacral areas expand at the line of junction with the actinal membrane, and the rows of pores are more distinct than in the poriferous zones of the corona. The interambulacral plates are quite small; but both the ambulacral and interambulacral plates extend to the very centre of the actinostome, where the actinal membrane is attached to the outer edge of the teeth. There appear at the line of junction between the actinal plates and the primary interambulacral plates interstices corresponding in position to those which give passage to the gills in the recent Echinothuridæ on each side of the poriferous

zone. The teeth are grooved as in the Cidaridæ. The face of the pyramid of the jaw is like that of the recent Echinothuridæ, remarkable for the length of the teeth compared to the height of the pyramid which is much less than is the case in the Echinidæ. The upper foramen of the pyramid is very small, the cheeks of the pyramids are deeply cut by a triangular pit which forms a narrow edge, the outer side of the pyramid, and a well-marked dividing wall with parallel edges between these two deep triangular depressions, a modification of the structure of the pyramid, which as yet has not been seen in any of the recent Echinidæ. See also Müller's figure of the pyramid (Neue Echinod. d. Eifeler Kalk., pl. iii. fig. 12). From the drawings of Trautschold of *Archæocidaris rossica* the jaws of the genus resemble most closely those of *Cidaris*.

In the Cystocidaridæ of Zittel (*Echinocystites* of Wy. Thomson and Hall) the jaws are apparently very different from those of the Perischoechinidæ, but they are not sufficiently well known to compare them to those of other Echinoderms, though they would appear from the drawings of Thomson to approach somewhat the mouthpieces of the Starfishes and Ophiurans. The anal system of this group of Echinids is also excentric and not placed at the apex of the test, where the other plates of the apical system are placed,—a structural feature which was supposed to be characteristic only of the higher Echinoidea, the Spatangoids and Clypeastroids.

But by far the most embryonic of all Echinoidea, and the most interesting of the Palæozoic Sea-urchins, is the remarkable genus *Bothriocidaris*, in which, if the figures of Schmidt[1] are correct, there is absolutely nothing to distinguish the plates of the actinal or abactinal systems from those of the coronal plates proper in the ambulacral and interambulacral areas. The ambulacra extend unbroken to the very plates which constitute the edge of the actinal opening, and the interambulacral areas, which consist only of a single row of plates, to the last row of plates surrounding the actinostome; and at the abactinal pole the plates pass similarly without any change into the minute plates which must have made up the anal system. As in all young Echinids the test also is made up of a small number of coronal plates very uniform in size on both the ambulacral and interambulacral zones, and diminishing only slightly in size towards the actinal and abactinal systems.

It seems quite evident from the above, and from the examination of the species of *Phormosoma* and *Asthenosoma* collected by the Challenger, that the Palæechinidæ are far more closely allied to the recent Echinids than is usually supposed, and that we have in the recent Echinothuridæ structural features combining the characteristics of the normal Desmosticha and of the Palæechinidæ to such an extent that we are hardly justified in regarding the Palæechinidæ as a subdivision of the Echinoidea equivalent to that of the Clypeastroids or Spatangoids.

In the Echinothuridæ the pedicellariæ in their general character are allied to those of the Diadematidæ, more specially to those of *Astropyga*. The long-headed long-stemmed

[1] Fr. Schmidt, Neue Balt. Sil. Petref., Mem. Acad. St Petersb., vii[e]. Série, xxi., pl. iii.

pedicellariæ of *Asthenosoma grubii* (Pl. XLII. fig. 9) are very similar to those of *Astropyga* (Revis. Echini, pl. xxiv. fig. 40). Of the globular-headed short-stemmed pedicellariæ, however, some differ totally from those of that group; they are remarkable for the great width of the base and of the upper extremities of the valves (Pl. XLII. fig. 8, *Asthenosoma grubii*). An interior and an exterior view of the valve of a similar pedicellaria of *Phormosoma luculentum* is given on Plate XLIV. figs. 25, 26, while, on the contrary, the general structure of the long-headed pedicellariæ of *Phormosoma* (Pl. XLIV. figs. 19, 20, *Phormosoma tenue*) closely resembles that of the same kind of pedicellariæ in *Centrostephanus* (Revis. Echini, pl. xxiv. fig. 37), which are remarkable for the large open meshwork structure of the central part of the valve (Pl. XLIV. fig. 19, *Phormosoma tenue*, and Pl. XLIV. fig. 36, *Asthenosoma grubii*). These vary greatly in size on different parts of the test. This open reticulation is indicated in some of the Echinidæ, but is quite apparent in *Pseudoboletia* (Pl. XLIV. fig. 39).

The rods which support these pedicellariæ are uniform in structure, they resemble the rods of the pedicellariæ of the Diadematidæ; they all have a slight constriction at the head (Pl. XLIV. figs. 24, 28, 31, 32).

The Echinothuridæ also have (Pl. XLIV. fig. 34) short-stemmed globular pedicellariæ, resembling closely the abactinal pedicellariæ of *Aspidodiadema*, but with coarser toothed valvular edges. In addition to the remarkable long-pronged pedicellariæ, figured by Thomson as characteristic of the group, we have also remarkable bottle-shaped didactyle pedicellariæ, which are perhaps only modifications of the former (Pl. XLIV. figs. 21, 22, *Phormosoma tenue*). They are at once distinguished by their regular reticulation, the small size of the base, the broad fan-like expansion of the extremity, with the raised edges, forming a deep triangular space at the upper end of the valve. This bottle-shaped pedicellaria is only a modification of the ordinary type of pedicellariæ in which the terminal edge becomes raised to form a spoon-shaped valve. Another modification of it is formed by the gigantic pedicellariæ (Pl. XLIV. fig. 29, 29′), in which this cup-like cavity extends along the shank connecting it with the base (see also Pl. XLIII. fig. 1).

Asthenosoma.

Asthenosoma, Grube, 1867, Jahresb. der Schles. Ges. f. Vat. Cult.

**Asthenosoma grubii* (Pls. XV., XVI., XVII., XXXVIII. figs. 1, 2, 4; Pl. XLII. figs. 8, 9; Pl. XLIII. fig. 2; Pl. XLIV. figs. 32–36).

Asthenosoma Grubei, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 200.

This is a pentagonal species with rounded corners (Pl. XV. fig. 1, Pl. XVI. fig. 1), quite flattened when in alcohol (Pl. XV. fig. 2), with nearly vertical ambitus. Thickly covered on the actinal side (Pl. XVI. fig. 1) with curved, hollow, primary radioles, which

are short, flaring at the extremity, of a greenish colour, banded with white and brown, or with violet brown transverse bands. These are of a very uniform size both over the ambulacral and interambulacral areas of the actinal surface; these curved spines extend only to the edge of the ambitus, where they are replaced by short sharp spines (Pl. XVI. fig. 6*a*–*c*) covered by a muscular sheath, the extension of the cuticle of the test (Pl. XVI. figs. 2, 3, 4, 7–9) which in the shorter spines of the ambulacral area and of the median interambulacral zone (Pl. XVI. figs. 7–9) forms a simple bag at its extremity, while in the somewhat longer spines both of the edge of the ambulacral and of the interambulacral zones the sheath is constricted in several places according to the length of the spines (Pl. XVI. figs. 2-4), and is frequently banded with transverse patches of colour.

The whole test both on the actinal and abactinal sides carries short, sharp, slender miliary spines (Pl. XVI. fig. 5), similar in structure to the longer spines of the abactinal surface (Pl. XVI. fig. 6.) This extension of the muscular sheath of the test over the spine or a portion of the spine is characteristic of those spines of Echinothuridæ in which, owing to the absence of the milled ring proper as in other Echinids, the spines have retained a more or less embryonic structure, and the muscular belt which, starting from the edge of the scrobicular circle in Echinoids, generally terminates at the milled ring, extends in some species of this family along the shaft of the spines either along a part of the shaft or beyond its tip. This is a feature which is eminently characteristic of all young Echinids which I have had occasion to examine. It rèminds us also of the mode of growth of the pedicellariæ as a protuberance of the calcareous test covered by the general cuticle covering the whole test, which eventually forces its way through this as also do the young spines of Echinids, while in some of the Echinothuridæ this sheath remains permanently growing with the growth of the spines of the abactinal region. In other species of the group (*Asthenosoma coriaceum*) this cuticle extends over the miliary tubercles with rudimentary spines, leaving small pits which are more or less regularly arranged along the coronal plates of the test. These spines differ materially from the primary spines of the Perischoechinidæ, which so far as is known are provided with a milled ring. The tubercles also are both perforate, imperforate and not crenulate, differing in this respect from those of the Diadematidæ proper. Towards the abactinal system and over the actinal system the integument of the test is so thick as to conceal completely the sutures of the plates. The elongated narrow actinal plates are remarkable (Pl. XVII. fig. 4) for the arrangement of the small tubercles they carry in regular horizontal rows concentric with the test; the pair of pores, the continuation of the poriferous zone, are placed in the centre of each actinal plate.

In the abactinal system (Pl. XVII. figs. 2, 3) the ocular and genital plates, with the exception of the madreporic body, are indicated when denuded of spines by a large, somewhat indistinct plate, smooth towards the ocular or genital pore and covered with coarse granulation at the anal edge. The anal system itself is covered by coarse distant granu-

lation. The genital plate carrying the madreporic body is raised round the edges, depressed in the centre, and extremely prominent. The anal opening is in the centre of the anal system in the middle of a small ring formed by the rising of the integument of the anal system. On the actinal side the large primaries of the interambulacral areas are arranged in horizontal rows (Pl. XVII. fig. 1), well separated by irregular groups of secondaries and miliaries, the tuberculation is quite regular in size over the whole of the interambulacral areas. In the ambulacral areas there are from two to three primary tubercles on each plate, between the poriferous zone and the median line separated by one or two miliaries or secondaries (Pl. XVII. figs. 1, 6), with a horizontal line of secondaries separating the rows of pores towards the outer edge of the plates and a cluster of the smaller tubercles near the median angle of the ambulacral plates.

On the abactinal side the coronal plates become very gradually narrower and narrower as they extend from the ambitus towards the abactinal system, and at the same time the integument of the test separating the plates increases in width; the primary tubercles diminish gradually in size and distinctness (Pl. XVII. fig. 2) until towards the abactinal system the tubercles are reduced to indistinct granules (Pl. XVII. fig. 3), forming more or less regularly curved narrow bands, with a re-entering curve towards the median line, indicating the position of the interambulacral coronal plates (Pl. XVII. fig. 2).

The same takes place in the median ambulacral spaces, but as the tubercles are originally smaller the change takes place nearer the ambitus. In the median ambulacral line a bare band separates the tubercles of adjoining plates, and a similar bare band separates the outer row of pores from the interambulacral plates. The poriferous zone is broad at the ambitus: it is broader than the corresponding part of the ambulacral plate. It diminishes very gradually in width towards the abactinal system, and forms on the abactinal side of the test three vertical rows of pairs of pores (Pl. XVII. fig. 2). The two inner rows are placed quite close together, the outer well separated from the two inner rows (Pl. XVII. fig. 5) and further distinguished by a vertical row of small secondary tubercles running between it and the two rows. On the actinal side these three rows can be distinguished only near the ambitus (Pl. XVII. fig. 1); they soon become extremely irregular by the gradual narrowing of the poriferous zone, so that about half-way between the ambitus and the actinal edge the three rows are united (Pl. XVII. fig. 6), the pairs of pores having become contiguous and forming a slightly oblique row of three pairs of pores.

This species is probably the same which Grube first described as *Asthenosoma varium*. His original description was, however, so short that Echinologists did not recognise the importance of the discovery of the genus, and Thomson himself when he first mentions *Calveria* in the Depths of the Sea could not suspect its identity with *Asthenosoma*, as *Calveria* does not possess the peculiar sheathed spines so characteristic of

Asthenosoma varium, and as Grube said nothing of the lapping of the coronal plates. It was only on seeing the original specimen at Breslau that I recognised the identity of the genera. At that time (1870) Professor Grube was kind enough to give me a few spines of this species, and on comparing them subsequently with those of the species called here *Asthenosoma grubii*, there seemed to exist sufficient differences in them, and more especially in the greater size of the primary tubercles of the actinal surface (of which Professor Grube had sent me a drawing), to warrant me in separating these species for the present. Grube's specimen is much smaller than the specimens collected by the Challenger, so that it may yet turn out that the differences existing between our specimens are merely due to age. The perforation of the tubercles of the abactinal surface is so small that it could not be represented on the natural size drawing of Plate XVII. fig. 2. It was, however, unfortunately omitted on the figure of the actinal side (Pl. XVII. fig. 1). It is shown on the enlarged figures (Pl. XVII. figs. 5, 6). The locality of Grube's specimen was not definitely known; as it came from Salmin, who had at the time of its purchase extensive dealings with the Philippine Islands, it undoubtedly came from the Eastern Seas of China or that neighbourhood. The specimens of the Challenger all coming from such a shallow depth as ten fathoms it is quite possible that this species may be a littoral one, or at any rate that it lives in comparatively shallow water. In the species of *Asthenosoma*, judging from the single smaller specimen of *Asthenosoma grubii* and from those of *Asthenosoma pellucidum*, the changes due to growth do not seem to be as marked as in *Phormosoma*. The smallest specimen of *Asthenosoma grubii* (measuring 115 mm.) already showed the principal specific characters of the adult (183 mm. in diameter), the only important differences being such as are readily accounted for by the size of the specimens. The few spines left on the abactinal surface of this smaller specimen show that the peculiar sheathed spines so characteristic of this species already exist in specimens of a comparatively small size.

Samboangan; 10 fathoms.

**Asthenosoma pellucidum* (Pl. XVIII. figs. 1–6; Pl. XVIII.[a] figs. 14–17; Pl. XIX. figs. 1–6; Pl. XXXVIII. fig. 6; Pl. XL. figs. 39–42).

Asthenosoma pellucida,[1] A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 200.

In this species of *Asthenosoma* the primary tubercles form a prominent vertical row in the interambulacral area adjoining the poriferous zone, the tubercles being largest near the ambitus both above and below the ambitus (Pl. XVIII. figs. 4, 5; Pl. XIX. figs. 4, 5). In the ambulacral areas there are only secondary tubercles, three or four of which on the abactinal side are somewhat larger than the others near the ambitus. From the large primary interambulacral tubercles extends a more or less regular horizontal row

[1] The new species of *Asthenosoma* and of *Phormosoma* were inadvertently published with feminine terminations. This error was not noticed in time to correct the lettering of the plates.

of secondary and miliary tubercles, occupying the middle region of each plate, and extending to the median line (Pl. XVIII. figs. 4, 5). On the ambulacral plates the secondaries are distant and more irregularly arranged than on the interambulacral plates (Pl. XVIII. fig. 1, 2, 4, 5). The coronal plates vary in colour from greenish to light violet brown, the intervening bare spaces of the membrane of the test are of a milky colour.

The suckers of the tentacles are tipped with orange on the actinal side. The test of this species is remarkably thin, even in the largest specimen (64 mm. in diameter), the calcareous plates do not give to the test any degree of solidity. In alcohol the general outline of the test is angular with rounded corners, and when seen in profile the edges of the test are somewhat swollen, the test sinking below the level of the ambitus between it and the actinostome, and also between the ambitus and the abactinal system. There are three kinds of pedicellariæ found upon the test resembling those of the test of *Phormosoma.* The pointed suckers of the abactinal side are large, and commence close to the ambitus. In Plate XVIII. fig. 6, the abactinal system has accidently been drawn out of line; the axis passing through the madreporic body should be on the left to have it correspond with the other figures of the abactinal system on the same plate. The larger primary spines, especially those near the ambitus on the actinal surface, resemble somewhat the curved trumpet-shaped hollow spines of *Asthenosoma grubii;* they are, however, longer, more slender, and of a lighter colour and transversely banded with vermilion, the other secondary and miliary spines of both areas are shorter, sharp pointed, and only a few of the primary spines of the abactinal surface near the ambitus are trumpet-shaped; the others resemble the secondary spines, but are larger and comparatively stouter, and are more or less irregularly banded with carmine.

In young specimens (Pl. XVIII. figs. 1, 2; Pl. XVIII.[a] figs. 14, 15) the vertical row of primary tubercles adjoining the poriferous zone is not as well marked as in the older specimens, nor are the horizontal rows of secondaries and miliaries well defined. In the smallest specimens collected (Pl. XIX. fig. 1–3) the spines are transversely banded with broad carmine rings. In young specimens the primary spines are proportionally longer, but as in older specimens of this species they are cylindrical, scarcely tapering towards the tip. The secondary and miliary spines are fine, sharp pointed and uniformly tapering. The integument of the abactinal system nearly conceals the calcareous plates irregularly arranged round the anal opening, and also encroaches considerably on the outer edges of the plates of the genital ring. The ocular plates are pentagonal, horizontally elongate; the genital plates (Pl. XVIII. fig. 6) are pear-shaped, pointed towards the median interambulacral line. The genital and ocular plates carry two or three secondary tubercles near the anal edge.

In somewhat younger specimens the abactinal system is marked for the greater uniformity in the size of the genital and ocular plates (Pl. XVIII. fig. 3).

Young specimens of *Asthenosoma pellucidum* (Pl. XVIII. figs. 1, 2) show how close is the relationship between the genera *Phormosoma* and *Asthenosoma* in spite of the apparently great structural differences existing between the adult of such species as *Asthenosoma grubii* and *Phormosoma luculentum*. It is mainly from the comparatively larger number of coronal plates in the former genus that the young of the two genera can be satisfactorily distinguished, the other characteristic features, the lapping of the plates appearing only in larger specimens. There is nothing in the growth of *Asthenosoma* corresponding to the splitting up into separate plates of the primary coronal plates so characteristic of *Phormosoma* when seen from the interior of the test (Pl. XVIII.[a] figs. 4, 5, 7, 8).

Each primary plate of *Phormosoma*, consists of a number of plates most irregular in shape (Pl. XVIII.[a] figs. 4, 7), held together quite loosely by the inner integument of the test, the joints of the plates are often foliated, and the centre is strengthened by a thicker deposition of calcareous matter forming a sort of button extending beyond the level of the plate towards the interior of the test. This thickening which corresponds to the lower side of one of the primary tubercles I have described more in detail in the description of *Phormosoma tenue*. This species differs from both *Asthenosoma hystrix* and *Asthenosoma fenestratum* in having a smaller number of coronal plates, these are consquently higher; in *Asthenosoma pellucidum* this difference becomes very striking in the height of the plates of the ambulacral areas. The open spaces between the coronal plates are largest on the actinal surface where they appear first in the younger stages and gradually extend to the abactinal surface with increasing size. In a small specimen measuring 36 mm. in diameter, the coronal interstices are limited to a narrow line parallel to the edge of the plates. In specimens measuring 44 mm. the coronal interstices assume already the elongated form represented in Plate XVIII. fig. 4. In the smallest specimen of this species examined, measuring 36 mm. in diameter, the gills are reduced to a small forked appendage protruding between the edge of the coronal plates and the mailed actinal membrane. In the older specimens of *Asthenosoma pellucidum* there is a decided thickening of the epidermis of the test, which tends gradually to obliterate the outlines of the coronal plates. We have this character developed to a great degree in *Asthenosoma coriaceum*. Unfortunately, the largest specimens of *Asthenosoma pellucidum* are so much smaller than the smallest *Asthenosoma coriaceum* or the single specimen of *Asthenosoma tessellatum*, that I am unable to satisfy myself that the present species (*Asthenosoma pellucidum*) may not be the young of *Asthenosoma coriaceum*. In the only species of the group of which the Challenger collected a complete series (*Phormosoma tenue*) there was little difficulty in recognising the young as belonging to the adult, the same was the case for *Phormosoma luculentum*. The changes in the coronal plates are not as great, and the arrangement of the pores does not seem to vary as much in *Phormosoma* as in *Asthenosoma*.

Off Cebu, 100 fathoms.

Station 192. September 26, 1874. Lat. 5° 42′ S.; long. 132° 25′ E.; 129 fathoms; mud.

**Asthenosoma coriaceum* (Pl. XVII.[a] figs. 5–7).

Asthenosoma coriacea, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 201.

This is a large species allied to *Asthenosoma grubii* in having an extremely thick leathery cuticle, but readily distinguished from it by the greater height of the coronal plates; in specimens of the same size there are more than twice as many plates as on the abactinal surface of *Asthenosoma grubii*. The plates of the abactinal surface carry but few primary spines limited to the neighbourhood of the ambitus; while on the actinal surface the plates bear over a great part of the floor, long comparatively stout hollow primary spines but slightly curved and very slightly flaring, resembling more nearly the primary actinal spines of *Phormosoma* than the characteristic flaring trumpet-shaped spines of *Asthenosoma*. The abactinal surface is nearly bare; it carries but few primaries near the ambitus, and small, short, sharp secondaries and miliaries confined mainly to the outer edges of the ambulacral and interambulacral zones. With this exception the general arrangement of the tubercles both in the ambulacral and interambulacral areas resembles that of *Asthenosoma tessellatum*; the coronal plates are also more prominently pitted (Pl. XVII.[a] figs. 6, 7), and towards the abactinal system, where the plates are very narrow, their presence is indicated by angular rows of pits following the course of the coronal plates (Pl. XVII.[a] fig. 7). It is quite possible, as I have stated in the preliminary Report of the Challenger Echini (Proc. Am. Acad., 1879, vol. xiv. p. 201), that this may be the adult of *Asthenosoma tessellatum*, yet from the identity already clearly apparent in specimens differing far more in size in other species of the genus, both in *Asthenosoma pellucidum* and in *Asthenosoma grubii*, I am inclined to keep it distinct for the present, as in the specimens of *Asthenosoma tessellatum*, measuring 140 mm., and in one of *Asthenosoma coriaceum*, 220 mm. in diameter, there is only a difference of a few plates in the number of coronal plates, while we might expect, judging from their size, a greater difference in the number.

Station 173. July 24, 1874. Lat. 19° 10′ S.; long. 179° 40′ E.; 315 to 310 fathoms; coral.

Station 172. July 22, 1874. Off Nulcualofa, Tongatabu; 18 and 240 fathoms; coral.

**Asthenosoma tessellatum* (Pl. XII.[a] figs. 14, 15; Pl. XIX.[a] fig. 1; Pl. XIX.[b]).

Asthenosoma tessellata, A. Agassiz, 1879, Proc. Am. Acad., vol xiv. p. 201.

Only a single specimen of this species was collected; it is of a dark chocolate colour,

with the narrow coronal plates of a lighter violet tint forming a most regular pavement on the actinal and abactinal surfaces of the test. The interstices between the coronal plates are even more developed in this species than in *Asthenosoma fenestratum*, extending as they do from the edge of the poriferous zone nearly to the extremity of the coronal plate in the median interambulacral space where they lap. The lapping of the plates is very marked in this species, even when seen from the outside (Pl. XIX.[b] fig. 2). The lapping of the ambulacral plates is not so well marked except in the older plates towards the ambitus on the abactinal surface. The encroachment of the interambulacral plates on the outer edge of the ambulacral plates is also shown from the exterior, the wings of the extremities of the plates covering the ends of the corresponding plates of adjoining areas, as has been already noticed by Thomson in *Asthenosoma hystrix*. On the actinal side this lapping is not well seen, the plates appearing externally to abut regularly both in the ambulacral and interambulacral areas (Pl. XIX.[a] fig. 1) as in the Desmosticha proper; but an examination of the interior of the test shows the lapping of both areas to be as prominent as in the figure of *Asthenosoma hystrix* given by Thomson (Porcup. Echin., Trans. Roy. Soc., 1874, pl. lxv. fig. 2). The primary spines of this species are few in number (Pl. XIX.[a] fig. 1, Pl. XIX.[b] figs. 1, 2), and are limited to a few plates near the ambitus on the actinal and abactinal surfaces, in addition to the single prominent row extending from the actinostome a short distance over the ambitus, to the abactinal region (Pl. XII.[a] figs. 14, 15, Pl. XIX.[a] fig. 1, Pl. XIX.[b] fig. 2) along the outer edge of the interambulacral zone next to the poriferous zone. The other spines, secondary and miliary, are also few in number, and slender, and are irregularly arranged on the ambulacral and interambulacral plates; there are a number of miliary tubercles forcing their way through the cuticle, which appear as pits (Pl. XII.[a] figs. 14, 15). The gills in this species are large and prominent (Pl. XIX.[a] fig. 1). Judging from the single alcoholic specimen the ambulacral tentacles of this species must have been of an unusual size (Pl. XIX.[a] fig. 1, Pl. XIX.[b]), especially near the ambitus both on the actinal and abactinal surfaces. The sucking disks are not large even on the actinal surface, and on the abactinal surface they soon become, beyond the ambitus, more slender and pointed (Pl. XIX.[b] fig. 4). The abactinal system is comparatively smaller than in *Asthenosoma coriaceum*, and differs mainly in the position of the genital openings which are relatively more distant from the centre than in *Asthenosoma coriaceum*; the tuberculation of the anal system is also coarser in the latter species and is covered by larger plates. Compare Plate XIX.[b] fig. 3, and Plate XVII.[a] fig. 5.

Station 204. November 2, 1874. Lat. 12° 43′ N., long. 122° 10′ E.; 100 fathoms and 115 fathoms; mud.

* *Asthenosoma gracile*, n.sp. (Pl. XVII.[a] figs. 1–4).

This species resembles *Asthenosoma hystrix* in having comparatively narrow elongated

coronal plates, while in its general appearance, its colouring, and the structure of the spines it approaches *Asthenosoma tenue.* Notwithstanding that there is but a single adult specimen of this species, I have no hesitation in describing it as distinct. The colour of the test in alcohol is yellowish, the spines of the same tint, with large violet patches on the actinal surface. The special characters of *Asthenosoma gracile* are the two irregular rows of small primary tubercles in the ambulacral area extending about half-way to the abactinal system from the ambitus, and in the interambulacral areas the coronal plates near the ambitus carrying from three to four primary tubercles (Pl. XVII.[a] fig. 4); while further towards the abactinal region the number of large tubercles is gradually reduced to one on every other plate. There are secondaries or miliaries loosely and irregularly arranged on the narrow plates; the interstices between the coronal plates of both areas are much as they are in *Asthenosoma hystrix,* judging from the width of the connecting membrane. On the actinal side the primary tubercles of the interambulacral area form, as they do in *Asthenosoma hystrix,* two principal vertical rows extending from the ambitus to the actinostome, the one adjoining the poriferous zone, the other in the median line; the rest of the plate is occupied by from four to seven small secondaries with a few miliaries arranged in irregular horizontal rows (Pl. XVII.[a] fig. 3). In the ambulacral area the primary tubercles are small, arranged in an irregular vertical row nearer the median line, with secondaries and miliaries placed much as they are in the interambulacral zone. The actinostome of the specimen figured natural size on Plate XVII.[a] fig. 1, measured 26 mm. in diameter, the abactinal system 16 mm. The primary spines are short, slender, blunt at the extremity, differing mainly in size from the shorter and sharper secondaries and miliaries. On the actinal surface, however, the spines of the actinal membrane are slightly curved and spathiform, and a few of the primary spines are also curved, trumpet-shaped, flaring at the extremity. The abactinal system (Pl. XVII.[a] fig. 2) differs from that of *Asthenosoma pellucidum* in having large pointed genital plates extending into the median interambulacral space and comparatively small ocular plates, while the abactinal system of *Asthenosoma pellucidum* is remarkable for the uniform size of the ocular and genital plates (Pl. XVIII. fig. 6).

Small specimens of *Asthenosoma* from Stations 184 and 219 are referred to this species with considerable doubt. The largest of these young specimens differs more from *Asthenosoma gracile* (figured on Pl. XVII.[a]) than young specimens of corresponding size differ from *Asthenosoma pellucidum.* The arrangement of the tubercles on the abactinal surface (Pl. XII.[a] fig. 5) in a specimen measuring 24 mm. is such as would be found in a species of *Asthenosoma* at any rate closely allied to *Asthenosoma gracile,* although the appearance of the actinal surface is more like that of a *Phormosoma* than that of an *Asthenosoma,* and the size and position of the ocular plates (Pl. XII.[a] fig. 5) is different from that of the oldest *Asthenosoma gracile* figured on Plate XVII.[a]

Dr Studer (Monatsber. Berlin Akad., 1876, p. 464) has described from Great Harbour,

New Britain, a very remarkable *Astropyga* which he calls *Astropyga elastica;* unfortunately it is as yet not figured, but, judging from his description, it is closely allied both to *Asthenosoma* and to *Astropyga;* the coronal plates of the tests resembling in structure those of *Asthenosoma*, while the facies of the species and the arrangement of the spines recall *Astropyga radiata*. This species was not collected by the Challenger, but some of the young specimens of Echinothuridæ which have been provisionally named may ultimately prove to belong to this type; perhaps the young I have temporarily referred to *Asthenosoma gracile* from Stations 184 and 219. The differences to be observed in the structure of the test and arrangement of the spines in the figures of the young specimens called *Asthenosoma gracile* and the normal *Asthenosoma* and *Phormosoma* are quite striking when we compare them with the figures of an undoubted young *Asthenosoma* (*A. pellucidum*) and of a genuine *Phormosoma* (*P. tenue*).

Station 219. March 10, 1875. Lat. 1° 50′ S., long. 146° 42′ E.; 150 fathoms; mud.

Station 200. October 23, 1874. Lat. 6° 48′ N., long. 122° 25′ E.; 255 fathoms; mud.

Station 184. August 29, 1874. Lat. 12° 8′ S., long. 145° 10′ E.; 1400 fathoms; bottom temperature, 1·8° C.; grey ooze.

Station 169. July 10, 1874. Lat. 37° 34′ S., long. 179° 22′ E.; 700 fathoms; bottom temperature, 4·2° C.; grey ooze.

Phormosoma.

Phormosoma, Wy. Thom., 1874, Echin. Porcup., Trans. Roy. Soc., vol. clxiv., part 2, p. 732.

**Phormosoma tenue* (Pls. XIII., XIV., XVII.[a] fig. 8; Pl. XVIII. figs. 7–9; Pl. XVIII.[a] figs. 1–13; Pls. XVIII.[b], XVIII.[c] figs. 5–9; Pl. XIX. figs. 7–9; Pl. XIX.[a] fig. 2; Pl. XXXVIII. fig. 5; Pl. XXXIX. fig. 9; Pl. XL. figs. 29, 30; Pl. XLII. fig. 7; Pl. XLIV. figs. 19–24).

Phormosoma tenuis, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 202.

In a large specimen (Pl. XIII. fig. 1) measuring 133 mm. in diameter, the primary tubercles (when seen from the abactinal side) are small and irregularly distributed over the whole of the abactinal surface both in the ambulacral and interambulacral areas; these tubercles carry slender, hollow, cylindrical spines tapering but little at the extremity, the intertubercular space is occupied by a few distant miliaries and secondaries carrying small sharp spines. Immediately on the edge of the test are seen a few of the large primary tubercles which on the actinal surface occupy the outer edge of the test and are arranged in vertical rows, diminishing very rapidly in size as they approach the actinostome (Pl. XIX.[a] fig. 2). The spines of these large tubercles are cylindrical, hollow, and a few of them surmounted by a short conical hoof. These large spines are far less prominent than in such species of the genus as *Phormosoma hoplacantha*, *Phormosoma luculentum*,

and the like. The general colour of the test of this species is yellowish-grey, the sutural lines of the coronal plates are distinct, and the poriferous zone and ambulacral system well defined from the ambitus to the actinostome, the ambulacral tentacles prominent, swollen, tapering, and tipped with a slight sucker, while they become pointed on the abactinal system and are much less prominent. The miliaries and secondaries of the actinal surface are more numerous than upon the abactinal surface. In a smaller specimen measuring not more than 91 mm. in diameter the difference between the tuberculation of the actinal and abactinal surfaces is not so marked (Pl. XIX. figs. 7, 8). The scrobicular area, it is true, is already covered by the swollen integument attached to the base of the spine, but there is no such striking difference as in the adult; the greater prominence of the ambulacral zone of the actinal surface, however, already exists (Pl. XIX. fig. 8). The sutures of the plates are also better defined, and the coronal plates are not yet broken up into secondary plates. The line of demarcation between the actinal membrane and the coronal plates is not so well defined, and the same is the case as to the line of demarcation between the abactinal system and the coronal plates adjoining the anal system. There is no material difference in the arrangement of the plates or of the pores, but the coronal plates of young specimens overlap but little, and the genital as well as the ocular plates (Pl. XVIII. fig. 9) are far more distinct than in the adult where the large anal plates have forced their way between them.

Thomson was the first to call attention to the peculiar structure and arrangement of the internal organs of this group;[1] the observations here recorded will supplement the earlier ones of Thomson.

The genital organs are narrow; they branch slightly, forming small clusters on each side of a long median tube. They extend not more than half-way from the abactinal system towards the edge of the test (Pl. XIV. fig. 1). The main ambulacral tube is large and specially prominent on the actinal side (Pl. XIV. fig. 2) where the ambulacral pores are closely crowded together, and the lateral tubes extending to them from the main tubes form, as has been noted by Thomson, a series of parallel tubes across the median ambulacral plates (Pl. XIV. figs. 2*a*, *a'*). These lateral tubes are finer and more distant in the abactinal part of the test (Pl. XVIII.[b] figs. 10, 11) forming delicate lines merely, not visible without being magnified (Pl. XIV. fig. 1). The general arrangement of the alimentary canal reminds us of that of the Diadematidæ (see plate xxvii., Revis. Echini); but in addition we find that the mesenteries attaching it to the test form in this family (as has already been noticed by Wyville Thomson) a series of partitions in the shape of large open horse shoes, extending over the ambulacral systems and confining the loops of the alimentary canal to the interambulacral spaces (Pl. XIV. fig. 2). The extremities and edges of these mesenteries are attached to the actinal and abactinal floors by exceedingly fine threads. The whole system of horse shoes thus forms a sort of pouch, with

[1] Echinoidea of the Porcupine Expedition, Trans. Roy. Soc., vol. clxiv. part 2, plate xlvi.

five openings to the interambulacral spaces; this pouch confines the alimentary canal within a proportionally small area of the test, no single fold of the alimentary canal extending beyond half-way from the actinostome to the edge of the test (Pl. XIV. fig. 2).

The alimentary canal coming out from the jaws into the left anterior interambulacral area (seen from the inside) runs just inside of the auricles, along the edge of the principal plates to the right ambulacral space, where it turns back again, runs outside the auricles completely round the actinostome to the right interambulacral space where it makes another turn, and then, forming great loops in extending outwards in the interambulacral spaces and shorter loops turned towards the actinostome in the ambulacral spaces, it passes to the anal opening in the right anterior interambulacral space (Pl. XIV. fig. 2).

Plate XII. fig. 2, shows for *Phormosoma hoplacantha* the position of the alimentary canal as it starts from the jaws and runs just inside of the auricles; it also shows the mode of attachment of the mesenteries of the horse-shoe pouch to the abactinal system, and the complete separation by this returning fold of the space in which the ovaries are placed from the poriferous zone, as is seen in Pl. XIV. fig. 2 on the actinal side.

In this species of *Phormosoma*, as in the genus so far as has been observed, the plates overlap in the opposite direction in the ambulacral and interambulacral spaces.

In the interior view of the test of *Phormosoma tenue* (Pls. XIV., XVIII.[a] figs. 1–13) the lapping of the whole edge of the plate, so characteristic of *Phormosoma*, is well seen, the double line round each coronal plate showing the extent of the overlapping, and the double line along the outer edge of the ambulacral zone shows the extent of the lateral covering of the edge of the ambulacral area. In *Asthenosoma* it is only the extremities of the ambulacral and interambulacral plates which lap along the median line and along the line of junction of the two areas, while in *Phormosoma* this lapping extends along the whole horizontal edge of the plate in both areas. In *Asthenosoma*, viewed from the outside, the outer and inner lower edges of the coronal plates pass under the upper edges of the preceding plate in the interambulacral areas, while in the ambulacral area it is the upper edges of the plates which pass under the lower edges of the succeeding plates counting from the actinostome.

In the actinal system seen from the interior (Pl. XVIII.[b] fig. 6) the ambulacral tubes pass under the auricles to plates immediately adjoining the teeth, where they are connected by a circular tube (Pl. XVIII.[b] fig. 4). The ampullæ are large, and the tubes leading to them distinct. A series of mesenteries separating the ambulacral from the interambulacral system, extend from the base of the auricles to the actinal edge of the actinal system.

The structure of the actinal and abactinal systems in this family shows most satisfactorily the embryonic characters of the family and the intimate connection the plates composing these two systems have, the one with the base of the actinal extremity of the ambulacral system and the other with the abactinal plates of the interambulacral system.

We find here no such sharp line of demarcation as exists in other regular Echinids between the abactinal system (composed of the anal system and the plates forming the genital ring) and the abactinal extremity of the coronal plates; the abactinal system in nearly all the groups except the Diadematidæ being in the adult set in, as it were, independently within the upper extremity of the coronal plates. In some of the Diadematidæ we find something analogous to the structure of the abactinal system in this group. In *Echinothrix, Diadema* and *Astropyga* the long-pointed triangular genital plates, encroaching far into the median interambulacral line and separating the opposing abactinal plates of the interambulacral areas, form the beginning of a closer connection between the outer plates of the anal system and the new plates of the interambulacral area. This connection is so close that it is well-nigh impossible to state with certainty whether the new interambulacral plates formed at the abactinal extremity are derived from the splitting up of the upper interambulacral plates or of the outer plates of the anal system (see Pl. XVIII.[b] figs. 1, 2). In both these figures the anal plates intercalated between the genital and ocular plates cannot be distinguished from the adjoining interambulacral plates. This intercalation is not so apparent in the younger stage figured on Plate XVIII. fig. 9.

In the same way at the junction of the actinal plates with those of the ambulacral system the continuity is unbroken (Pl. XVIII.[b] fig. 3; Pl. XII. fig. 4), and although there are a few additional plates formed at the line of junction of the two systems, yet at a very early stage the number of plates characteristic of the actinal system are formed, and the growth of the test merely separates the suckers piercing the actinal membrane; although the additional plates of the actinal membrane are formed, as I have shown, from the separation of the last small intercalated ambulacral plate and its subsequent lateral growth.

Neither in *Asthenosoma* (Pl. XVII. fig. 1) nor in *Phormosoma* (Pl. XII. figs. 3, 4; Pl. XVIII. fig. 8; Pl. XVIII.[b] fig. 3) are there any prominent actinal cuts for the passage of the gills; there are slight indentations between the plates at the actinal junction of the ambulacral and interambulacral systems, and the gills appear in the youngest stages I have examined.

The plates covering the actinal membrane are, with the exception of a few in the outer central part opposite the median interambulacral line, all ambulacral plates occupying the whole of the membrane (Pl. XVII. fig. 4; Pl. XVIII.[b] fig. 3). The arrangement of the actinal plates in this family, and their close structural connection with the plates of the ambulacral system, are a further step in showing the gradual modifications which the actinal ambulacral plates have undergone, so as to form gradually an imbricating actinal membrane such as is characteristic of the Cidaridæ, passing into an actinal membrane in which we find, as in the majority of the regular Echinids, only ten buccal plates, the rest of the membrane being more or less strengthened by irregularly arranged imbricating plates which may form a thick close pavement, as in some species of *Echinus* and the like, or else an entirely bare membrane with a few scattered calcareous

spicules as in the bulk of the Diadematidæ. In fact the Echinothuridæ strongly recall to us the embryonic stages of our regular Echinids (*Strongylocentrotus* and *Arbacia*) in which the distinction between the coronal plates and the actinal and abactinal systems does not exist, and in which the whole test is made up of plates of similar structure. The Echinothuridæ are somewhat more differentiated than the Perischoechinidæ, in which the coronal plates themselves are still very numerous and not reduced to the typical number of two plates for the interambulacral system, as in all the Echinoidea known at the present period; but even in the Echinothuridæ we still have a trace of this abnormal character of the Perischoechinidæ, of having a number of rows of plates in the interambulacral system.

Some of the species of the genus *Phormosoma*, in which the test is most flexible, such as *Phormosoma tenue*, show traces of an irregular subdivision of the coronal plates both on the actinal and abactinal sides (Pl. XIII. fig. 1, Pl. XIV. figs. 1, 2, Pl. XIX.[a] fig. 2). Diagonal or transverse lines are seen to run from one plate to the next, so as to subdivide the primary coronal interambulacral plate into two or three, and sometimes four or five secondary plates; each one of these secondary plates corresponding usually to a primary or secondary tubercle. This breaking up of the primary plates, of course, gives to the test a much greater mobility than it had before in spite of the extreme tenuity of the test (Pl. XVIII.[a] figs. 4, 5, 7, 8). These secondary plates, although extremely thin round the edges, are strengthened in the centre by a deposition of carbonate of lime forming a circular button in the centre (Pl. XVIII.[a] fig. 4), to strengthen that part of the plate which carries the primary tubercles and spines. This splitting up of the coronal plates into plates corresponding each to a primary tubercle exists also to a certain extent on the actinal surface of *Astropyga*, though it has not to my knowledge been noticed before. The thickness of the inner and outer fold of the cuticle of the test forms lines more or less coincident with the secondary plates of the interambulacral areas (Pl. XIV. figs. 1, 2; Pl. XVIII.[a] fig. 7). This gives us, I think, a natural explanation of the structure of the coronal interambulacral areas of the Perischoechinidæ, only in this group the splitting up of the primary interambulacral coronal plates was quite regular, and the lines of sutures are regularly placed as in the ambulacral system. It is remarkable that in the Spatangoids, the Clypeastroids, and all the higher Petalosticha, the arrangement of the plates of the ambulacral system should have remained comparatively simple as well as in the most embryonic group of the Desmosticha, the Cidaridæ and Salenidæ, while in the Perischoechinidæ, the Echinothuridæ, and by far the larger number of the Desmosticha, the arrangement of the plates of the ambulacral system is quite complicated, and the number of rows of plates across the ambulacral areas greater than that of the interambulacral areas (which are, of course, limited to two in the bulk of the recent Desmosticha).

Grube and Thomson have already called attention to the similarity in the structure of the teeth of the Echinothuridæ and Diadematidæ. Thomson has figured the teeth of *Phormosoma placenta* (Porcupine Echinids, Trans. Roy. Soc., 1874, pl. lxiii. figs 9, 9*a*), and I have

figured the teeth of another type of *Phormosoma* (*Phormosoma tenue*) on Pl. XVIII.[b], these teeth differ considerably in the size of the foramen of the pyramids, and the shape and prominence of the median ridge. The jaws of *Phormosoma tenue* are proportionally more solid than those of *Phormosoma placenta*, and also broader in proportion to their height.

The plates of the actinal membrane imbricate, as do those of the test, away from the actinostome. In the abactinal system the membrane is only partly covered by the plates, leaving a marked reticulation between them; the tubercles of these plates are very indistinctly crenulate and surrounded by a broad smooth areolar space. The whole surface of the abactinal part of the test is dotted by delicate pigment (violet) spots. In the ambulacral areas these spots are closely packed round the openings for the passage of the suckers, forming a delicate ring at the base; the suckers near the abactinal region become pointed (Pl. XVIII.[b] fig. 12). Suckers are present on the actinal region somewhat beyond the ambitus (Pl. XVIII.[b] fig. 13). On the abactinal surface of a specimen measuring 168 mm. in diameter (Pl. XVIII. fig. 7), the primary tubercles are arranged on the interambulacral area in two irregular vertical rows. Towards the ambitus the tubercles are more numerous, arranged in three or four irregular rows. The secondary tubercles are irregularly arranged, increasing in number towards the edge of the test. In the ambulacral area there are two irregular vertical rows of primary tubercles, and, adjoining the ambulacral pores, on the interior edge, secondary tubercles are arranged in an irregular vertical row; these, as well as the primary tubercles, become more numerous towards the edge of the test. The primary tubercles of the abactinal region are smaller than the large primary tubercles which cover the actinal region, being really intermediate in size between them and the secondary tubercles. The pedicellariæ of the abactinal surface of the test are scattered over the whole surface of the test. They are, however, more numerous in the ambulacral area, and in the adjoining part of the interambulacral area. The pedicellariæ are long stemmed with a small head articulating with a second stem, from twice to three times the length of the head (Pl. XVIII.[a] fig. 11). A second kind of pedicellaria with an inverted conical head, and a comparatively stouter joint articulating upon a long stem occurs not unfrequently upon this surface of the test (Pl. XVIII.[a] fig. 13). They resemble those figured by Thomson for *Calveria hystrix.*

Close to the ambitus on the actinal side the primary tubercles take a great development, the scrobicular areas of the tubercles of the interambulacral and the single one of the ambulacral area occupying the greater part of a plate, but except on three or four of these large primary plates the other tubercles near the actinostome soon assume the proportions of those of the abactinal surface (Pl. XIX.[a] fig. 2), but they are placed close together.

The secondaries, miliaries, and pedicellariæ, are also far more numerous on the actinal side of the test, and we find there a third kind of pedicellaria with a shorter articulation

and a large head, irregularly scattered among the others of the same kind as on the abactinal side (Pl. XVIII.[a] fig. 12). I have not found the peculiar tetradactyle pedicellariæ (Echinids of Porcupine, Trans. Roy. Soc., 1874, pl. lxvii. fig. 6) described by Thomson as so characteristic of *Phormosoma fenestratum.* In this species the ambulacral plates perforated by the pores are larger than in *Phormosoma placenta* figured by Thomson.

Phormosoma tenue and *Phormosoma uranus* are at once readily distinguished from *Phormosoma placenta* on account of the greater similarity in the structure of the actinal and abactinal surface of the test.

Station 274. Sept. 11, 1875. Lat. 7° 25′ S., long. 152° 15′ W.; 2750 fathoms; bottom temperature, 0·9° C.; radiolarian ooze.

Station 237. June 17, 1875. Lat. 34° 37′ N., long. 140° 32′ E.; 1875 fathoms; bottom temperature, 1·7° C.; mud.

Station 272. Sept. 8, 1875. Lat. 3° 48′ S., long. 152° 56′ W.; 2600 fathoms; bottom temperature, 1·0° C.; radiolarian ooze.

**Phormosoma luculentum* (Pls. IX., X., X.[a] figs. 3–7; Pl. XXXIX. fig. 8; Pl. XL. figs. 31–36; Pl. XLIV. figs. 25–27.

Phormosoma luculenta, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 201.

This is perhaps the most striking of the Echinothuridæ collected by the Challenger. The test is of a beautiful light violet colour, forming a brilliant contrast to the white lines (Pls. IX., X., X.[a] figs. 3, 4) indicating the sutures of the coronal plates, to the jet black or deep violet, long smooth shiny primary spines, and to the silvery white hoofs tipping the large primary spines of the ambulacral and interambulacral areas scattered here and there along the edge of the test, when seen from the abactinal side, and projecting over the lower surface of the test when seen from the actinal side. This species is marked by the long narrow coronal plates of the abactinal surface (Pl. IX. fig. 1; Pl. X.[a] fig. 3), the small size of the few primary tubercles irregularly placed on the abactinal side of the test near the ambitus, the narrow ambulacral system, and the narrow poriferous zone. The abactinal surface of the test is covered by short, sharp miliary and secondary spines, few in number, and irregularly placed on the plates, leaving the test nearly bare, although pitted with numerous miliaries carrying no spines (Pl. X.[a] fig. 3). On the actinal side the primary tubercles are large, and are arranged in three more or less regular horizontal rows near the ambitus (Pl. X.[a] fig. 4); these tubercles are surmounted by large hollow cylindrical spines tipped with truncated conical hoofs (Pl. X. fig. 1).

The small secondaries scattered over the actinal surface carry short club-shaped or pointed spines (Pl. X. fig. 1). The flat intertubercular spaces are filled by short, sharp miliary spines closely packed together between the larger primaries near the ambitus,

but few in number between the secondary tubercles of the inner part of the test where the white lines separating the coronal plates are again quite as prominent as on the abactinal surface (Pl. X. fig. 1), while on the outer third of the test towards the ambitus the sutures of the plates are concealed by the thickened cuticle extending over the scrobicular area of the large primary tubercles, and by the crowded miliaries and secondaries. The miliaries, though more crowded, do not form (Pl. X.[a] fig. 4) as in *Phormosoma placenta* the very characteristic edge running along the ambitus as described by Thomson, which takes almost the prominence of a fasciole (see also *Phormosoma bursarium* for the description of a similar fasciole), and is interesting as showing how such a structure may exist in a rudimentary form in the Desmosticha.

Both in this species and in *Phormosoma bursarium* (Pl. X.[b]) the differences between the primary spines of the actinal and abactinal surface is very striking. In the one (*Phormosoma luculenta*) we have the actinal surface with its large hollow primary spines tipped with the enormous white conical hoof (Pl. X. fig. 1) and the small sharp or club-shaped miliaries and secondaries, while the abactinal surface carries long slender curved primary spines gradually tapering to a point with short, sharp secondary and miliary spines (Pl. IX. fig. 1). In the other (*Phormosoma bursarium*) the general appearance of the abactinal spines (Pl. X.[b]) is quite similar to that of *Phormosoma luculentum*, while on the actinal side we find the remarkable primary spines with the bag-like terminal appendage simulating the hoof of the other Echinothuridæ. In *Phormosoma luculentum* a few of the secondary ambulacral and interambulacral spines near the apical system resemble the peculiar sheathed spines so characteristic of the whole of the abactinal surface of *Asthenosoma grubii* (Pl. X.[a] figs. 5, 6).

The actinal membrane is covered by secondary tubercles arranged in irregular concentric rings round the actinostome (Pl. X. fig. 3; Pl. X.[a] fig. 4), carrying slender spines slightly club-shaped at the end. The abactinal system is characterised by the large size of the anal plates extending from near the central part of the anal system to the edge of the abactinal system (Pl. X. fig. 2; X.[a] fig. 3); each of these irregularly-shaped plates carries from one to two slender secondary spines. The genital plates are small and elliptical, widely separated from the indistinct ocular plates by the plates of the anal system encroaching upon the genital ring. The madreporic body is not prominent.

In this species, as in *Phormosoma hoplacantha*, the continuation of the poriferous zone from the abactinal side to the actinostome is exceedingly irregular (Pl. X. fig. 1; Pl. X.[a] fig. 4), and although on the actinal side the sutures of the ambulacral and interambulacral plates and of the poriferous zone are well defined, the poriferous zone never becomes prominent and regular again as on the abactinal side.

Thomson has already noticed the very irregular course of the poriferous zone on the actinal surface of *Phormosoma* (Porcupine Echinoidea, Trans. Roy. Soc., 1874).

The outline of this species seen in profile is probably more nearly correct than that

of the others figured in the same attitude. The test of *Phormosoma luculentum* is far more rigid than that of many of the species of the family, so that with its stiff flattened actinal surface it clearly shows a rounded ambitus and a somewhat conical outline as in Plate IX. fig. 2.

In a species of *Phormosoma* closely allied to *Phormosoma placenta* and *Phormosoma luculentum,* which frequently came up in the dredgings of the "Blake" during the expedition of 1878–79, the outline of the test when seen in profile was somewhat like the figure of Plate IX. fig. 2, only the abactinal surface was more globular, and the flattened actinal surface even sometimes bent upwards towards the edge near the ambitus. Still, in all these specimens of *Phormosoma* there was a very decided contrast between the flattened actinal surface and the comparatively high globular abactinal surface.

In the species of *Asthenosoma,* on the contrary, there was no such contrast between the actinal and abactinal surfaces, the outline being in living specimens when seen in profile nearly globular, as if the test had been blown up like a football. This is seen in specimens which came up from moderate depths near 100 fathoms, and in which no difference of pressure would account for such excessive expansion.

The very differently shaped coronal plates composing the test of *Phormosoma,* near the actinostome, in the outer half of the actinal surface, and on the abactinal surface of the test (Pl. X.[a] figs. 3, 4), as well as the striking difference in the course and arrangement of the poriferous zone on the two sides of the test, plainly show how hazardous it is among the Palæechinidæ to multiply the genera and species allied to *Archæocidaris* and *Pholidocidaris* on structural features found combined in one and the same species of the recent Echinothuridæ. In this species of *Phormosoma* (*P. luculentum*), the flat intertubercular space between the deeply sunken areolas of the primary spines is broad, and does not form as in *Phormosoma bursarium* the well-defined ridge so characteristic of that species which recalls so strongly a similar structural feature in *Archæocidaris.*

Station 200. October 23, 1874. Lat. 6° 48′ N., long. 122° 25′ E.; 255 fathoms; mud.

Station 205. November 13, 1874. Lat. 16° 42′ N., long. 119° 22′ E.; 1050 fathoms; bottom temperature, 2·4° C.; grey ooze.

Station 191. September 23, 1874. Lat. 5° 41′ S., long. 134° 4′ E.; 800 fathoms; bottom temperature, 3·9° C.; mud.

**Phormosoma bursarium*, n. sp. (Pl. X.[b]).

I was inclined at first to consider the specimens on which I have distinguished this species as belonging to *Phormosoma luculentum,* and to regard them as younger specimens. On a re-examination, and after a careful study of the younger stages of the different

species of the group, I am compelled, for the present at least, to distinguish this species from *Phormosoma luculentum*, although it is found associated with it. It resembles *Phormosoma placenta* in the closer tuberculation of the actinal surface (Pl. X.[b] figs. 3, 6), and differs from both *Phormosoma placenta* and *Phormosoma luculentum* in the greater height of its coronal plates, and the presence of large primary tubercles extending both in the ambulacral and interambulacral areas far towards the abactinal system (Pl. X.[b] fig. 4). These primary tubercles carry long curved spines (Pl. X.[b] fig. 1), of a whitish-yellow colour, and not filled with dark pigment as in *Phormosoma luculentum*. This, however, I do not consider a character of importance, depending as it does entirely upon the general colour of the test, which, in this species, is of a dirty orange-yellow, with a slight violet tint. The primary spines are comparatively stouter than in *Phormosoma luculentum*.

The most important feature which distinguishes this species at once from *Phormosoma luculentum* is the comparatively large abactinal system (Pl. X.[b] figs. 1, 4, 8), the genital openings extending well into the median interambulacral space between the upper coronal plates, and the larger number of the anal plates of the anal system than in *Phormosoma luculentum*. On the actinal surface (Pl. X.[b] fig. 2) the primary spines are not tipped with a solid hoof, but all end in a fleshy bag (Pl. X.[b] fig. 10), which gives these spines much the appearance of those of the actinal surface of *Micropyga*. There are from two to three primary tubercles on each interambulacral plate near the ambitus, and about half-way towards the abactinal system. In the ambulacral area the large primary tubercles extend nearly to the abactinal extremity of the ambulacrum. The lines of miliaries, extending round the test immediately at the ambitus, are more prominent than in *Phormosoma luculentum* (Pl. X.[b] fig. 7); still they do not correspond in the interior of the test to the remarkable band noticed by Thomson in that species.

This species is also characterised by its extremely narrow poriferous zone which, even on the abactinal surface, forms a more or less irregular vertical zone, composed of short arcs of three pairs of pores, and placed in close proximity to the outer edge of the poriferous zone (Pl. X.[b] figs. 3, 4, 5, 7). The number of primary tubercles near the ambitus is larger in *Phormosoma bursarium* than in *Phormosoma luculentum*. In a specimen of the former measuring 28 mm., there are four primary interambulacral tubercles to each plate, while in a large *Phormosoma luculentum* measuring 160 mm. there are only three large primaries. The miliaries of the abactinal surface are somewhat larger also than in *Phormosoma luculentum*, and less numerous; the interambulacral coronal plates of the latter species being pitted all over with miliary tubercles, sunk in the cutis of the test. The ridges separating the deeply sunken areolas of the primary tubercles of the actinal surface (Pl. X.[b] fig. 6) are quite narrow in *Phormosoma bursarium*, while in *Phormosoma luculentum* the primary tubercles near the ambitus are separated by flat spaces of the

test, more or less wide according to the size of the tubercles. The structure of the primary tubercles of the actinal surface, and their irregular arrangement in horizontal and vertical rows is very characteristic of the genus *Phormosoma*, and resembles in the most striking manner the arrangement and structure of the primary tubercles of *Archæocidaris* among the Palæechinidæ, showing that *Archæocidaris*, and perhaps *Eocidaris* and *Pholidocidaris*, are more closely related to the recent Echinothuridæ than the group of Palæechinidæ, to which *Melonites* and the like belong, which, as far as we can judge, from what we know of the structure of the apical system, and of the actinal membrane are more closely related to the Cidaridæ.

The presence of sheathed spines in two species of *Phormosoma* shows that this character, which at first sight seems to separate so strikingly from the rest of the species of the group *Asthenosoma grubii*, is evidently one of little value, and which may be more or less developed in specimens of the same species in the same state of growth.

In a specimen of *Phormosoma luculentum*, measuring nearly 160 mm. in diameter, the abactinal system measured 22 mm., the actinal opening 42 mm.; while in a specimen of *Phormosoma bursarium*, measuring 100 mm. in diameter, the abactinal system measured 28 mm., the actinal opening 40 mm. The smaller specimens of these two species collected from the same localities could readily be assigned to their respective species, yet more abundant material may prove that the differences noticed, although important, are simply individual characteristics partly due to age.

Station 200. October 23, 1874. Lat. 6° 48′ N., long. 122° 25′ E.; 255 fathoms; mud.

Station 205. November 13, 1874. Lat. 16° 42′ N., long. 119° 22′ E.; 1050 fathoms; bottom temperature, 2·4° C.; grey ooze.

Station 232. May 12, 1875. Lat. 35° 11′ N., long. 139° 28′ E.; 345 fathoms; bottom temperature, 5·0° C.; sandy mud.

**Phormosoma hoplacantha* (Pls. XI., XII., XII.[a] figs. 10–13; Pl. XXXIX. figs. 3–7; Pl. XL. figs. 37, 38; Pl. XLIII. fig. 1; Pl. XLIV. figs. 28–31).

Phormosoma hoplacantha, Wy. Thomson, 1877, Voyage of Chall., Atlantic, vol. i. p. 148, fig. 35.

This is the largest Sea-urchin with which I am acquainted, it measures no less than 312 mm. in diameter, and when fully expanded, must have been a striking object. This species is remarkable for the large size of the primary tubercles, arranged both on the actinal and abactinal surface of the interambulacral areas (Pl. XII.[a] figs. 11–13) in horizontal rows; on the abactinal surface they are distant, separated by large secondaries and miliaries, irregularly arranged on the coronal plates (Pl. XII.[a] fig. 13). Towards

the abactinal system the primaries decrease in size and number, leaving the abactinal portion of the test covered by secondaries and miliaries for one-third the distance from the abactinal system to the ambitus. The arrangement of the tubercles is similar in the ambulacral system, the tubercles being, however, somewhat smaller. The primary spines are cylindrical, hollow, of uniform length (Pl. XI. fig. 1); those of the actinal system are capped with a gigantic, white, truncated conical hoof (Pl. XI. fig. 2). The spines of the secondary tubercles and of the miliaries are sharp, shorter, more slender, pointed, and tapering. The actinal system (Pl. XI. fig. 2) is thickly covered with short stouter spines, carried by the secondaries, and granules covering the plates of the actinal membrane (Pl. XII. fig. 4). The abactinal system is less well covered with spines (Pl. XI. fig. 3), the granulation of the anal system is quite uniform in size (Pl. XI. fig. 4), and the anal system is towards its outer edge covered by large irregularly-shaped plates, with slightly raised edges separating the plates of the genital ring; these plates carry no tubercles, only an indistinct granulation. The genital and ocular plates are fringed by an irregular row of miliaries (Pl. XI. fig. 4).

In *Phormosoma*, viewed from the outside, and counting from the actinostome, the whole upper edge of the plates of the ambulacra pass under the lower edge of the succeeding plates, while in the interambulacral areas it is the lower edge which passes under the upper edge of the preceding plate (Pl. XII.[a] figs. 11, 12).

Seen from the actinal side, the poriferous zone cannot well be traced through the mass of spines, and when denuded, is seen to extend very irregularly towards the actinostome (Pl. XII. fig. 4; Pl. XII.[a] fig. 10).

As in *Phormosoma bursarium*, *Phormosoma placenta*, and other allied species, the depressed areolas of the large primary tubercles of the actinal surface form distinct projecting rings on the interior of the test (Pl. XII.[a] fig. 11).

In alcohol the colour of the specimens of this species is dark violet, almost black both for the test and spines, and this formed a marked contrast to the white tips of the spines on the actinal surface.

The existence of primary spines tipped with hoofs as in the Arbaciadæ is an interesting structural feature connecting groups which thus far seemed somewhat isolated in their relationship to other Echinids. Thomson in the Voyage of the Challenger (vol. i.) figured these remarkable spines of the actinal surface of *Phormosoma hoplacantha* on p. 148, fig. 35, where he speaks of the wear of the base of the cones as if they had been in use for "vigorous locomotion" over the ground, as we know to be the case in one of the species of *Arbacia* of the eastern North American coast. In the Echinothuridæ the conical tip does not extend along the sides of the extremity of the spine, forming, as in the Arbaciadæ, a kind of cap; it is merely attached by a nearly horizontal base to the more flattened end of the spine. In consequence of this mode of attachment the tip is frequently lost.

Station 300. December 17, 1875. Lat. 33° 42′ S., long. 78° 18′ W.; 1375 fathoms; bottom temperature, 1·5° C.; globigerina ooze.

Station 164*a*. June 13, 1874. Lat. 34° 13′ S., long. 151° 38′ E.; 410 fathoms; grey ooze.

Station 235. June 4, 1875. Lat. 34° 7′ N., long. 138° 0′ E.; 565 fathoms; bottom temperature, 3·3° C.; mud.

**Phormosoma uranus* (Pl. XVIII.[c] fig. 12).

Phormosoma uranus, Wy. Thomson, 1877, Voyage of the Challenger, Atlantic, vol. i. p. 146, fig. 33, p. 147, fig. 34.

Thomson has figured in the Voyage of the Challenger (vol. i. p. 146, fig. 33, p. 147, fig. 34), a species of *Phormosoma* differing greatly from that collected by the Porcupine and named by him *Phormosoma placenta* (Trans. Roy. Soc., 1874, vol. clxiv. part 2, p. 732, Pls. lxii. lxiii.); the latter species was remarkable for the large tubercles of the actinal surface occupying with their areolas the greater part of the ambulacral and interambulacral plates. The present species is more closely related to *Phormosoma tenue*, in which the large tubercles are not closely packed but irregularly arranged and limited to a comparatively narrow edge of the abactinal surface immediately adjoining the ambitus. It differs also from specimens of *Phormosoma tenue* in the arrangement of the poriferous zone, which is well shown by Thomson on fig. 34; the intercalated ambulacral plate is proportionally large and still extends to the outer edge of the ambulacral area, the poriferous zone thus forming a nearly vertical line (somewhat irregular) of pores extending from the actinal opening to the abactinal area; the species holds, as Thomson has noticed, an intermediate place between *Phormosoma* and *Asthenosoma*.

The extreme tenuity of the test of this species is very remarkable, the coronal plates of the abactinal area of the only specimen collected are so thin that the test can be rolled up without injury to the specimen. The shape of the plates of the ambulacral zone on the abactinal side at once distinguish this species from *Phormosoma tenue*, in which the corresponding plates are comparatively narrower, while the primary ambulacral plates of *Phormosoma uranus* are fully as high as the corresponding interambulacral plates. This is not the case in *Phormosoma tenue* (see Pl. XIV. fig. 1).

Among the Echinoidea dredged by the last "Blake" expedition there are a number of specimens of a species closely allied if not identical to *Phormosoma uranus*; as these are of all sizes I may be able to ascertain how far the characters which I have used to distinguish *Phormosoma uranus* and its Pacific representative are constant.

Station 6. January 30, 1873. Lat. 36° 23′ N., long. 11° 18′ W.; 1525 fathoms; bottom temperature, 1·6° C.; globigerina ooze.

Station 78. July 10, 1873. Lat. 37° 24′ N., long. 25° 13′ W.; 1000 fathoms; globigerina ooze.

Among the small specimens of Echinothuridæ there are a few which I am unable to refer satisfactorily to any one of the species here distinguished, and which are for the present described under distinct names, the one as *Phormosoma asterias* and the other as *Phormosoma rigidum,* both these species differing from any of the species of *Phormosoma* here described in having extremely narrow coronal plates more like the species of *Asthenosoma* allied to *Asthenosoma grubii* and *Asthenosoma hystrix.*

**Phormosoma asterias* n. sp. (Pl. XII.[a] figs. 7–9).

The only specimen collected measures 30 mm. in diameter, the whole abactinal surface both in the ambulacral and interambulacral areas is covered by primaries arranged in somewhat irregular lines along the median lines of the plates (Pl. XII.[a] fig. 9) with but few secondaries or miliaries on the plates near the ambitus. On the actinal surface, as in all young *Phormosomas,* there are from two to three primary tubercles (Pl. XII.[a] fig. 8) with secondary tubercles and miliaries irregularly scattered over the comparatively bare plates. The actinal membrane is as yet covered only by the ten large buccal plates with a couple of minute plates near the actinal edge of the test, the first trace of the imbricating buccal plates of older stages. The course of the poriferous zone is quite sporadic, and the limitation of the ambulacral and interambulacral areas ill-defined near the actinostome. In addition to these features the abactinal system is remarkable for the large size of the anal plates in so young a specimen, for the elongated pear-shaped ocular plates and the large triangular genital plates, some of which show traces of subdivision, as if the proximal extremities of the genital plates eventually became cut off to form a part of the anal system.

Colour of test light yellowish-red.

Station 299. December 14, 1875. Lat. 33° 31′ S., long. 74° 43′ W.; 2160 fathoms; bottom temperature, 1·1° C.; grey mud.

**Phormosoma rigidum* n. sp. (Pl. XII.[a] figs. 1–4).

The largest specimen collected measured only 40 mm. in diameter, and might readily pass as the young of some species of *Astropyga* were it not for the characteristic *Phormosoma* structure of the actinal surface (Pl. XII.[a] fig. 3) and of the abactinal system. The poriferous zone of this species is extremely narrow, more so than in corresponding stages of other species of *Phormosoma* (Pl. XII.[a] fig. 4), and it is still confined to the very outer edge of the ambulacral zone. The coronal plates of the actinal surface in both areas carry already two large primary tubercles (Pl. XII.[a] fig. 3), and the areolas show a slight trace of difference of level with the surrounding test, so that the whole of the actinal surface of the test appears thickly covered with large primary tubercles much as in *Phormosoma placenta.* The coronal plates of the abactinal surface are narrow and elongated, carrying, according to their size and position, from two to three primaries (Pl. XII.[a] figs.

1, 4), arranged in horizontal rows on the central part of the plate and forming indistinct vertical rows. There are but few small secondaries and miliaries. The abactinal system is large (Pl. XII.[a] fig. 2); the ocular plates are small, somewhat pear-shaped, scarcely exceeding in size some of the larger of the many plates covering the anal system; the genital plates are short, triangular. The colour of this species in alcohol is light violet-brown, the primary spines are slender pointed and comparatively short on the abactinal surface, stouter and somewhat larger on the actinal side.

Station 169. July 10, 1874. Lat. 37° 34′ S., long. 179° 22′ E.; 700 fathoms; bottom temperature, 4·2° C.; grey ooze.

ECHINOMETRADÆ.

Family ECHINOMETRADÆ, Gray, 1855, Proc. Zool. Soc. Lond.

Heterocentrotus.

Heterocentrotus, Brandt., 1835, Prod. Des. An.

Heterocentrotus mammillatus.

Cidaris mammillata, Klein, 1734, Nat. Disp. Ech.
Heterocentrotus mammillatus, Brandt, 1835, Prod.

Kandavu Reef.

Heterocentrotus trigonarius.

Echinus trigonarius, Lamk., 1816, Anim. sans Vert.
Heterocentrotus trigonarius, Br., 1835, Proc. Desc.

New Caledonia.

Echinometra.

Echinometra, Rondel, 1554, De Piscib. Mar. (Breyn.).

Echinometra lucunter.

Cidaris lucunter, Leske, 1778, Kl. Add.
Echinometra lucunter, Blainv., 1834, Actin.

Samboangan, 10 fathoms.
Kandavu Reef.
Tongatabu Reef. 18 fathoms. July 24, 1874.
Papeete Reef. September, 1875.
Honolulu. August, 1875.
Cebu, Philippine Islands.

Echinometra subangularis.

Cidaris subangularis, Leske, 1778, Kl. Add.
Echinometra subangularis, Desml., 1837, Syn.

St Vincent, Cape Verde Islands.

Ascension Island, shore.

Strongylocentrotus.

Strongylocentrotus, Brandt., 1835, Prod. Des. An.

Strongylocentrotus dröbachiensis.

Echinus Dröbachiensis, Müll., 1776, Zool. Dan. Prod.
Strongylocentrotus Dröbachiensis, A. Agassiz, 1872, Revis. Echini, part 1, p. 162.

Station 48. May 8, 1873. Lat. 43° 2′ N; long. 64° 2′ W., 51 fathoms; rocks. Le Have Bank.

Station 49. May 20, 1873. Lat. 43° 3′ N; long. 63° 39′ W., 83 fathoms; bottom temperature, 1·8° C.; gravel, stones.

Strongylocentrotus eurythrogrammus.

Echinus eurythrogrammus, Val., 1846, Voyage Vénus.
Strongylocentrotus eurythrogrammus, A. Agassiz, 1872, Revis. Echini, part 1, p. 163.

Port Jackson, 6 to 15 fathoms and 30 to 35 fathoms.

New Caledonia.

Strongylocentrotus gibbosus.

Echinus gibbosus, Val., 1847, in Ag. Des., C. R. Ann. Sc. Nat., vol. vii.
Strongylocentrotus gibbosus, A. Agassiz, 1872, Revis. Echini, part 1, p. 164.

Station 304. December 31, 1875. Lat. 46° 53′ S., long. 75° 11′ W.; 45 fathoms; sand.

Sphærechinus (*Strongylocentrotus*).

Sphærechinus, Desor, 1857, Syn. Éch. foss.

Sphærechinus australiæ.

Sphærechinus Australiæ, A. Agassiz, 1872, Bull. Mus. Comp. Zool., vol. iii.

Station 162. April 2, 1874. Bass Strait; 38 to 40 fathoms; sand.

Sphærechinus granularis.

Echinus granularis, Lamk., 1816, Anim. sans Vert.
Sphærechinus granularis, A. Agassiz, 1863, Bull. Mus. Comp. Zool., vol. i.

St Vincent, Cape Verde Islands.

Station 75. July 2, 1873. Lat. 38° 37′ N., long. 28° 30′ W.; 50 to 90 fathoms; sand.

Pseudoboletia (*Strongylocentrotus*).

Pseudoboletia, Trosch., 1869, Verhdl. d. Nat. Ver. f. Rheinl. u. West.

Pseudoboletia indiana (Pl. XXXVIII. fig. 3, Pl. XXXIX. fig. 11, Pl. XLIV. figs. 38–40).

Toxopneustes indianus, Mich., 1862, Maill. Bourbon, Ann. A.
Pseudoboletia indiana, A. Agassiz, 1872, Revis. Echini, part 1, p. 153.

Samboangan; 10 fathoms.

Echinidæ.

Family Echinidæ, Agassiz, 1846, C. R. Ann. Sc. Nat., vol. vi. (*emend.*).

Temnopleuridæ.

Sub-family Temnopleuridæ, Des., 1855, Syn. Éch. foss.

Temnopleurus.

Temnopleurus, Agassiz, 1841, Int. Mon. Scut.

Temnopleurus hardwicki.

Toreumatica Hardwickii, Gray, 1855, Proc. Zool. Soc. Lond.
Temnopleurus Hardwickii, A. Agassiz, 1872, Revis. Ech., part 1, p. 166.

Kobi, Japan. 8 to 52 fathoms. May 17, 1875.

Arafura Sea.

Off Yokohama. 8 to 14 fathoms and 5 to 25 fathoms.

Station 192. September, 26, 1874. Lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud.

Temnopleurus reynaudi.

Temnopleurus Reynaudi, Agassiz, 1846, C. R. Ann. Sc. Nat., vol. vi.

Station 192. September 26, 1874. Lat. 5° 42′ S., long. 132° 25′ E. 129 fathoms; mud.

Station 219. March 10, 1875. Lat. 1° 50′ S., long. 146° 42′ E. 150 fathoms; mud.

Station 166. June 23, 1874. Lat. 38° 50′ S., long. 169° 20′ E. 275 fathoms; bottom temperature, 10·0° C.; globigerina ooze.

Temnopleurus toreumaticus.

Cidaris toreumatica, Klein., 1734, Nat. Disp. Ech.
Temnopleurus toreumaticus, Agassiz, 1841, Int. Mon. Scut.

Station 203. October 31, 1874. Lat. 11° 7′ N., long. 123° 7′ E.; 12 to 20 fathoms; mud.

Pleurechinus (*Temnopleurus*).

Pleurechinus, A. Agassiz, 1841, Int. Mon. Scut.

Pleurechinus bothyroides (Pl. X.[a] figs. 1, 2).

Pleurechinus bothryoides, Agassiz, 1841, Int. Mon. Scut.

The Challenger collected three small specimens of a Temnopleurid, which I am inclined to refer to the sub-genus *Pleurechinus*, Agassiz (see Revis. Echini, p. 465); they are unfortunately not large enough to compare directly with the typical *Pleurechinus bothryoides.* They show clearly, however, that we may expect to find in the China Seas a species of *Temnopleurus* still retaining the principal features so characteristic of some of the nummulitic species of India, figured by D'Archiac and Haime (Animaux fossiles de l'Inde, see Plate XIII. fig. 7, of *Temnopleurus valenciennesi*), to which the specimens of the Challenger are most closely allied. The outline of the test, even in these young specimens, measuring (the largest) not more than 18 mm. in diameter, is high, resembling already somewhat the globular shape of such species of *Amblypneustes* as *Amblypneustes griseus*, and differing from the other species of Temnopleuridæ in which the outline of the test is quite conical at a corresponding stage. The genital ring (Pl. X.[a] fig. 1) is narrow, compact, slightly pentagonal; the genital plates are of uniform size, with the exception of the madreporic genital which is somewhat larger and rectangular in outline, the pores covering its entire surface with the exception of the space occupied by the ring of secondary tubercles, which runs along the inner edge of the genital plates, separating them from the anal system (Pl. X.[a] fig. 1). In addition to this edging of secondary tubercles, the genital plates carry from two to three similar tubercles irregularly placed on the plates and a few miliaries. The genital openings are deep crescent-shaped notches, cut out of the outer edge of the plates; the genital plates are united along the anal edge, and a distinct pit in the angle of the sutures between the genital and ocular plates separates the latter from the edge of the anal system. The anal system is covered by an outer row of large triangular plates with smaller slender elongate plates arranged round the anal openings. In the interambulacral area there are two disconnected elliptical pits at the two extremities of the horizontal sutures, separating the coronal plates (Pl. X.[a] fig. 2). The coronal plates carry from one to three large primary tubercles arranged in a horizontal row near the lower edge of the plate, with a somewhat undulating horizontal line of smaller secondary tubercles above that, the

rest of the plate being filled with granules, miliaries, and secondaries, irregularly arranged. In the ambulacral area the pits are only slightly smaller, but there is only a single large pit at the median end of the suture, the pit at the other extremity of the suture is reduced to a minute impression at the angle of the coronal plate adjoining the poriferous zone. There is a distinct vertical row of primary tubercles on the outer edge of the coronal plates, extending along the whole length of the poriferous zone, the rest of the ambulacral plate is occupied by an inner somewhat smaller tubercle, and an irregular horizontal line of secondaries with miliaries extending above the larger tubercle. The pores form very indistinct irregular vertical arcs of three pairs; the pores are separated by slight ridges, and the miliaries of the coronal plates sometimes encroach on the outer edge of the poriferous zone.

In alcohol the test is greenish, the tubercles standing out in greyish-white; the spines are short, slender, resembling those of *Salmacis;* they are yellowish, with three to four reddish-orange transverse bands more or less distinct.

Galapagos is mentioned as the habitat of this species in the Revision of the Echini; this is evidently a mistake, as thus far no species of Temnopleuridæ have been recorded from that locality. The specimens collected by the Challenger show conclusively that this genus has the same geographical range as the other members of the family.

Station 186. September 8, 1874. Lat. 10° 30′ S., long. 142° 18′ E.; 8 fathoms; coral sand.

Kobi, Japan; 8 to 50 fathoms. May 17, 1875.

**Prionechinus.*

Prionechinus, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 202.

The structure of the apical system of this genus is closely allied to that of the Salmacidæ. It resembles more, perhaps, that of the genus *Coptophyma* of Peron and Gauthier, figured on plate xv. fig. 11, Échin. foss. d'Algérie, Cotteau, Péron et Gauthier; but as in *Cottaldia*, there is but a single row of plates of pores of equal size in the ambulacral zone. The actinostome is somewhat indented, and the actinal membrane is covered by plates. The spines are serrated, somewhat flattened, differing radically in external appearance from the spines of the Triplechinidæ thus far known.

**Prionechinus sagittiger* (Pl. VI.[a] figs. 11–14; Pl. XL. figs. 43, 44).

Prionechinus sagittiger, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 202.

Unfortunately only poorly-preserved specimens of this interesting genus were collected; the largest, measuring 7·5 mm. in diameter, is evidently immature, though the genital openings are well developed. The actinal system of this species has ten large buccal plates (Pl. VI.[a] fig. 12), with others irregularly arranged; it resembles that of the

Echinidæ, of such forms as *Echinus miliaris*, but the opening of the actinostome is comparatively larger. In all the buccal plates the tentacle of one of the pairs is rudimentary or even wanting (Pl. VI.[a] fig 12). The test is thin, much as in the Salmacidæ, and it has as well as the spines a silvery lustre as in *Trigonocidaris*. The coronal plates are high; the pairs of large pores are arranged in a single vertical row.

The anal system is large, but still covered with a few large plates as in all young Echinidæ (Pl. VI.[a] fig. 13). The genital plates are of uniform size; the ocular plates are notched in the apex of the ambulacral row, they are excluded from the anal system. The primary tuberculation of the upper part of the test extends over the genital ring. The pedicellariæ are numerous, especially above the ambitus; they are all of the large-headed slender-stemmed form. The most striking feature of this genus, however, is the structure of the spines; thus far it was mainly among Cidaridæ, Salenidæ, Diadematidæ, and Arbacidæ, that the spines differed greatly in shape, in closely allied genera, or even in the species of the same genus. Among the Echinidæ, though we find in very young specimens marked serrations along the fluting of the spines, yet these disappear with age, forming a more or less uniform fluting in all the Echinidæ proper. In this genus, however, the spines of the test are still prominently serrated in comparatively large specimens (Pl. VI.[a] figs. 11, 11*a*), at least in specimens of a size which, in the young Echinidæ which have been examined, have all the features of the adult. In addition to the serrations they are also flattened (Pl. VI.[a] fig. 11*a*), resembling to a considerable extent some of the spines of *Salenia varispina*. What shape they assume in the adult will be interesting to discover. This genus is most interesting, as it is the first instance showing any relationship in the shape of the spines, between the genera of the Echinidæ proper, and the Cidaridæ and Salenidæ, in addition to the common structural features of the actinostome. This genus has also affinities to *Trigonocidaris* and others of the Salmacidæ as stated above.

The test is flattened, the actinal cuts are slight; there is one large primary tubercle on each coronal plate both of the ambulacral and interambulacral areas, forming in both areas very distinct vertical rows; the rest of the interambulacral plates carry small secondaries irregulary arranged round the centrally placed primary (Pl. VI.[a] fig. 14); in the ambulacral area the primaries are near the median line, separated from the poriferous zone by irregular arcs of secondaries. The poriferous zone is comparatively broad, the pairs of pores well separated vertically.

Station 164. June 12, 1874. Lat. 34° 8′ S., long. 152° 0′ E.; 950 fathoms; bottom temperature, 2·2° C.; grey ooze.

Station 218. March 1, 1875. Lat. 2° 33′ S., long. 144° 4′ E.; 1070 fathoms; bottom temperature, 2·1° C.; globigerina ooze.

Station 207. January 16, 1875. Lat. 12° 21′ N., long. 122° 15′ E; 700 fathoms; bottom temperature, 10·8° C.; mud.

Microcyphus.

Microcyphus, Agassiz, 1841, Val., Anat. Genre. Ech. (*non* Mon. Scut.).

Microcyphus zigzag.

Microcyphus zigzag, Agassiz, 1846, C. R. Ann. Sc. Nat., vol. vi.

Station 161. April 1, 1874. Off entrance to Port Philip; 38 fathoms; sand.

Station 162. April 2, 1874. Off East Moncœur Island, Bass Strait; 38 to 40 fathoms; sand.

Trigonocidaris.

Trigonocidaris, A. Agassiz, 1869, Bull. Mus. Comp. Zool., vol. i.

Laube has figured among the fossil Echinoidea of Murray Cliffs in Southern Australia a small Sea-urchin (*Paradoxechinus novus*), of which he gives an enlarged view of a part of the ambulacral and interambulacral areas. I am inclined to consider this interesting fossil as the Tertiary representative of *Trigonocidaris*. Laube's genus is probably identical with *Trigonocidaris*, but not having an authentic specimen I am unable to settle this point, and here merely call attention to their probable identity. The difference in the structure of the connecting ridges between the primary tubercles may be due to the state of preservation of the fossil. Laube's genus was described in the Sitzungsb. Akad. Wien., February 1869, while my preliminary description of *Trigonocidaris* did not appear till October of the same year.

According to the description of the ornamentation and the detail figures the ridges of *Paradoxechinus* are double zigzag lines of small tubercles, while in *Trigonocidaris* the zigzag lines uniting the tubercles are smooth ridges forming an irregular network of pits very unlike the regular triangles formed by the ridges connecting the primary tubercles. The only other genus of Echinids presenting such a structural feature is *Pleurodiadema* of Loriol (an oolitic form), in which, however, this arrangement of the granules or miliaries is in distinct ridges, but in this genus always running horizontally.[1]

**Trigonocidaris monolini* (Pl. VI.ª figs. 8–10).

Trigonocidaris monolini, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 203.

A single specimen from Station 170, measuring 8 mm. in diameter. This species is readily distinguished from *Trigonocidaris albida* by the structure of its actinal membrane (Pl. VI.ª fig. 8), and also by the striking ornamentation of the genital ring (Pl. VI.ª fig. 9) and by the relatively smaller number of primary coronal plates and their coarser pitted reticulation (Pl. VI.ª fig. 10). The ten ambulacral buccal plates of the actinal membrane occupy nearly the whole of the distal edge of the actinal ring, while in specimens of the same size of *Trigonocidaris albida* the pairs of plates are separated not only from each other

[1] See Cotteau, Échinides Nouveaux, Rev. Mag. Zool., No. 97, pl. xxvi.

but from the edge of the test by the imbricating plates which cover the whole of its actinal membrane. In this species the imbricating plates are more prominent in the space between the teeth and the ambulacral plates (Pl. VI.[a] fig. 8). The characteristic reticulation and pits of this genus are coarser both in the ambulacral and interambulacral spaces; the spines were mostly broken, but to judge from the secondary ones they must have been proportionally longer and stouter than in the Florida species. The shape of the anal system is not elongate in the direction of the axis of the large anal plate but at right angles to it, and the second and third anal plates are comparatively larger than in *Trigonocidaris albida* with two very minute plates intercalated over the anal opening between them and the small fourth anal plate (Pl. VI.[a] fig. 9). The abactinal system is ornamented by a prominent ridge, extending round the edge of the ocular plates and across the adjoining genital plates, forming a pentagon with rounded angles round the anal system (Pl. VI.[a] fig. 9).

Adjoining the anal system in the middle of the genital plates are placed two or three prominent secondary tubercles. This highly-ornamented apical system is in striking contrast to the smooth bare abactinal system of *Trigonocidaris albida.* The pedicellariæ resemble those of *Trigonocidaris albida,* but the head is somewhat blunter; in the single specimen collected they were most numerous close to the ambitus on the abactinal surface. In alcohol the colour of the test and spines of this specimen was silvery white with yellowish suckers on the abactinal side. The actinal side of the test was of a light dirty yellow.

Station 170. July 14, 1874. Lat. 29° 55′ S., long. 178° 14′ W.; 520 fathoms; bottom temperature, 6·0° C.; rocks.

Cottaldia, Des.

Cottaldia, Des., 1855, Syn. Éch. Foss.

**Cottaldia forbesiana* (Pl. VI.[a] figs. 15–17).

Cottaldia forbesiana, Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 203.

Only a single specimen of this interesting species was obtained from Station 173. It is allied to the Tertiary *Psammechinus monilis.* The pores are, however, arranged in simple vertical rows much as in *Temnechinus* (Pl. VI.[a] fig. 15); the spines of this species (Pl. VI.[a] fig. 17) closely resemble those of some species of *Salmacis* and of *Temnechinus.* It has, like *Temnopleurus* and the allied genera, a large abactinal system, but we find no trace of the indentations, grooves or pits of the above-mentioned genera. The general facies of the test when denuded resembles that of the species often united by Echinologists as *Psammechinus* [*Echinus,* pars] The actinostome is sunken as in *Temnopleurus* and *Salmacis,* a character in which it differs from *Cottaldia;* it may be best, however, to place it in that genus for the present until we have more material to ascertain its

true position. It has not, like the recent species of the old genus *Psammechinus*, the actinostome covered with plates; there are but ten large plates round the actinal opening; the madreporic body is slightly developed.

The spines are white and of a yellowish-orange at the base, short, slightly flattened, and deeply grooved (Pl. VI.[a] fig. 17). The primary tubercles are of the same size in both areas, forming a very marked vertical row in the ambulacral area; the secondaries are larger in the interambulacral spaces, they form indistinct horizontal rows near the ambitus (Pl. VI.[a] fig. 15). The genital plates are thickly covered by secondaries; the anal system is covered by comparatively few plates (Pl. VI.[a] fig. 16). The genital openings are small and sharply cut. This is evidently a young specimen. The colour in alcohol is yellowish-orange with whitish primary spines.

Station 173. July 24, 1874. Lat. 19° 10′ S., long. 179° 40′ E.; 315 to 310 fathoms; coral.

Salmacis.

Salmacis, Agassiz, 1841, Val., Anat. Genre Echinus.

Salmacis bicolor.

Salmacis bicolor, Agassiz, 1841, Val., Anat. Gen. Ech.

Samboangan; 10 fathoms.

Salmacis dussumieri.

Salmacis Dussumieri, Agassiz, 1846, C. R. Ann. Sc. Nat., vol. vi.

Station 212. January 30, 1875. Lat. 6° 55′ N., long. 122° 15′ E.; 10, 14, and 20 fathoms; sand.

Amboyna; 100 fathoms.

Salmacis globator.

Salmacis globator, Agassiz, 1846, C. R. Ann. Sc. Nat., vol. vi.

Station 186. September 8, 1874. Lat. 10° 30′ S., long. 142° 18′ E.; 8 fathoms; coral sand.

Salmacis rarispina.

Salmacis rarispinus, Agassiz, 1846, C. R. Ann. Sc. Nat., vol. vi.

Station 186. September 8, 1874. Lat. 10° 30′ S., long. 142° 18′ E.; 8 fathoms; coral sand.

Station 188. September 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E.; 28 fathoms; mud.

Station 203. October 31, 1874. Lat. 11° 7′ N., long. 123° 7′ E.; 12 to 20 fathoms; mud.

Salmacis sulcata.

Salmacis sulcatus, Agassiz, 1846, C. R. Ann. Sc. Nat., vol. vi.

Cebu, Philippine Islands. May 23, 1875.

Mespilia.

Mespilia, Des., 1846, in Agassiz, Des. C. R. Ann. Sc. Nat., vol. vi.

Mespilia globulus.

Cidaris granulata, Leske, 1778, Kl. Add.
Mespilia globulus, Agassiz, 1846, C. R. Ann. Sc. Nat., vol. vi.

Samboangan; 10 fathoms. February 1, 1875.

Amblypneustes.

Amblypneustes, Agassiz, 1841, Int. Mon. Scut.

Amblypneustes formosus.

Amblypneustes formosus, Val., 1846, Voyage Vénus.

Station 162. April 2, 1874. Bass Strait; 38 to 40 fathoms; sand.

Holopneustes (Amblypneustes).

Holopneustes, Agassiz, 1841, Anat. Genre Echinus.[1]

Holopneustes purpurescens.

Amblypneustes purpurescens, Lütk., 1872, in A. Agassiz, Bull. Mus. Comp. Zool., vol. iii.
Holopneustes purpurescens, A. Agassiz, 1872, Bull. Mus. Comp. Zool., vol. iii.

Port Jackson; 6 to 15 fathoms.

TRIPLECHINIDÆ.

Sub-family TRIPLECHINIDÆ, A. Agassiz, 1872, Revis. Ech., part 2.

Echinus.

Echinus, Rondel., 1554, De Piscib. (Linn.) (*emend.*).

Echinus acutus.

Echinus acutus, Lamk., 1816, Anim. sans Vert.

Station 343. March 27, 1876. Lat. 8° 3′ S., long. 14° 27′ W.; 425 fathoms; bottom temperature, 4·5° C.; coral.

Station 170. July 14, 1874. Lat. 29° 45′ S., long. 178° 11′ W.; 630 fathoms; bottom temperature, 4·0° C.; rock.

[1] Not Mon. Scut. as in Revis. Ech., p. 483.

Station 46. May 6, 1873. Lat. 40° 17′ N., long. 66° 48′ W.; 1350 fathoms; bottom temperature, 2·3° C.; mud.

Echinus angulosus.

Cidaris angulosa, Leske, 1778, Kl. Add.
Echinus angulosus, A. Agassiz, 1872, Revis. Ech., part 1, p 122.

Simon's Bay; 10 to 20 fathoms.

Echinus elegans.

Echinus elegans (Düb. o. Kor.), 1844, Skand. Ech.

Station 46. May 6, 1873. Lat. 40° 17′ N., long. 66° 48′ W., 1350 fathoms; bottom temperature, 2·3° C.; mud.

Tristan da Cunha; 1100 fathoms.

Station 219. March 10, 1875. Lat. 1° 50′ S., long. 146° 42′ E.; 150 fathoms mud.

* *Echinus horridus* (Pl. VI.[a] figs. 1–5).

Echinus horridus, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 203.

Fragments of a large conical *Echinus* were collected in the Straits of Magellan, which I am unable to refer to any of the species already known from that locality. It is readily characterised by its narrow poriferous zone, with its three pairs of pores, distant and placed in nearly vertical arcs on the abactinal surface (Pl. VI.[a] figs. 3–5), but so spaced that the two outer pairs form one vertical line, and the inner a second one; on the actinal side the poriferous zone is wider, the arcs are more horizontal, and placed nearer together (Pl. VI.[a] fig. 4). Both in the ambulacral and interambulacral areas, the single primary tubercle placed on each coronal plate (Pl. VI.[a] figs. 3, 4, 5) forms a most distinct vertical row. On the actinal side the primaries of both areas are nearly of a size (Pl. VI.[a] fig. 4), but on the sides of the test, above the ambitus, the ambulacral primaries decrease in size more rapidly than the corresponding interambulacral ones, as they approach the abactinal system (Pl. VI.[a] figs. 3, 5). On the actinal side the secondaries are irregularly arranged, and the intertubercular space of the plates is closely packed with miliaries and small secondaries, showing no definite arrangement (Pl. VI.[a] fig. 4).

On the sides of the test, however, some of the larger miliaries and secondaries form diverging lines more or less parallel to the horizontal sutures of the plates (Pl. VI.[a] figs. 3–5). This linear arrangement of the secondaries and miliaries is most prominent near the ambitus (Pl. VI.[a] fig. 3). The primary spines (Pl. VI.[a] fig. 2) are remarkable for their length, being even comparatively longer than in some specimens of *Echinus acutus*. The actinostome is comparatively smaller than in any other species of this genus, not as large as the abactinal system, with but slight buccal indentations. The actinal system was

entire only in a medium-sized specimen, but the fragments of the actinostome of a large specimen show that it does not increase greatly with age. The colour of the test (when dry) is light reddish-brown, the miliary and secondary spines of a darker colour, the shaft of the primary spines of the same colour as the test, somewhat darker at the base.

The abactinal system is remarkably compact and solid, with five large heptagonal plates covered by a close granulation of small secondaries (Pl. VI.[a] fig. 1), with large genital openings placed close to the outer edge of four of the plates. The madreporic plate is somewhat larger than the others, the madreporic body covering nearly the whole plate with the exception of the anal edge of the plate, which is covered by small secondaries like the other plates. The ocular plates are of uniform size, irregularly pentagonal, extending but little beyond the edge of the genital plates; they are covered with smaller secondaries than the genitals; the ocular pore is large. The anal system is covered by an outer row of large plates, one of which from its size is probably the original anal plate of the young, the rest of the anal system is covered by small irregularly-arranged plates (Pl. VI.[a] fig. 1).

There are two kinds of pedicellariæ, one small-headed, long-stemmed; the other short-stemmed with a conical head; the latter are the more numerous on the test.

This species is closely allied to *Echinus norvegicus*, judging at least from the medium-sized specimen, measuring 47 mm. in diameter (actinostome 8 mm.). This species, however, from the size of the fragments of the sides of the test, must attain a height of nearly 100 mm.

It has, like *Echinus microstoma* of Thomson (Porcupine Echinoidea, Trans. Roy. Soc., vol. clxiv. part 2, pl. lxviii. fig. 1), a small, somewhat sunken actinostome, but differs from it in the arrangement of the secondaries and miliaries.

Station 308. January 5, 1876. Lat. 50° 10′ S., long. 74° 42′ W.; 175 fathoms; mud.

Echinus magellanicus.

Echinus magellanicus, Phil., 1857, Wieg. Arch., vol. i.

Station 315. January 26, 1876. Lat. 51° 40′ S., long. 57° 50′ W.; 5 to 12 fathoms; sand and gravel.

Station 304. December 31, 1875. Lat. 46° 53′ S., long. 75° 11′ W.; 45 fathoms; sand.

Station 308. January 5, 1876. Lat. 50° 10′ S., long. 74° 42′ W.; 175 fathoms; mud.

Marion Islands; 50 fathoms.

Station 145. December 27, 1873. Lat. 46° 40′ S., long. 37° 50′ E.; 310 to 315 fathoms. Prince Edward Island.

Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E.; 1600 fathoms; bottom temperature, 0·8° C.; globigerina ooze.

Station 312. January 13, 1876. Lat. 53° 38′ S., long. 70° 56′ W.; 10 to 15 fathoms; mud.

Echinus margaritaceus.

Echinus margaritaceus, Lamk., 1816, Anim. sans Vert.

Studer (Monatsb. Berlin Akad, 1876, p. 456) has distinguished as distinct from *Echinus margaritaceus* a species which he has named *Echinus diadema*, this he separates on account of the absence of rows of secondary tubercles.

The Challenger has also collected from Kerguelen Island, 120 fathoms, specimens answering well to Studer's description, but I am not inclined to consider these specimens as a species distinct from *Echinus margaritaceus* after comparing them with specimens of this species collected by the "Hassler" in the Straits of Magellan, and on the east coast of Patagonia, as in some of these specimens there is a well marked tendency in the secondary tubercles to be arranged in horizontal and sometimes also in indistinct vertical rows.

Station 150. February 2, 1874. Lat. 52° 4′ S., long. 71° 22′ E.; 150 fathoms; bottom temperature, 1·8° C.; rocks.

Station 151. February 7, 1874. Off Heard Island; 75 fathoms; mud.

Station 308. January 5, 1876. Lat. 50° 10′ S., long. 74° 42′ W.; 175 fathoms; mud.

Off Christmas Harbour, Kerguelen; 50 fathoms and 120 fathoms. January 29, 1874.

Kerguelen Island; 120 fathoms.

Station 311. January 11, 1876. Lat. 52° 50′ S., long. 73° 53′ W.; 245 fathoms; bottom temperature, 7·7° C.; mud.

Echinus norvegicus.

Echinus norvegicus, Düb. o. Kor., 1844, Skand. Ech.

Station 308. January 5, 1876. Lat. 50° 10′ S., long. 74° 42′ W.; 175 fathoms; mud.

Station 232. May 12, 1875. Lat. 35° 11′ N., long. 139° 28′ E.; 345 fathoms; bottom temperature, 5·0° C.; sandy mud.

Station 235. June 4, 1875. Lat. 34° 7′ N., long. 138° 0′ E.; 565 fathoms; bottom temperature, 3·3° C.; mud.

Station 46. May 6, 1873. Lat. 40° 17′ N., long. 66° 48′ W.; 1350 fathoms; bottom temperature, 2·3°C.; mud.

Station 47. May 7, 1873. Lat. 41° 15′ N., long. 65° 45′ W.; 1340 fathoms; mud.

Toxopneustes.

Toxopneustes, Agassiz, 1841, Int. Monog. Scut.

Toxopneustes pileolus.

Echinus pileolus, Lamk., 1816, Anim. sans Vert.
Toxopneustes pileolus, Agassiz, 1841, Int. Monog. Scut.

Samboangan; 10 fathoms.

Honolulu.

Toxopneustes variegatus.

Echinus variegatus, Lamk., 1816, Anim. sans Vert.
Toxopneustes variegatus, A. Agassiz, 1872, Revis. Ech., part 1, p. 168.

Bermudas.

Hipponoë.

Hipponoë, Gray, 1840, Synops. Cont. Brit. Mus.

Hipponoë variegata.

Cidaris variegata, Leske, 1778, Kl. Add.
Hipponoë variegata, A. Agassiz, 1872, Revis. Ech., part 1, p. 135.

Samboangan; 10 fathoms. October 25, 1874.
Kandavu Reef.
Port Jackson; 6 to 15 fathoms.

Evechinus (*Hipponoë*).

Evechinus, Verrill, 1871, Notes on Radiata.

Evechinus chloroticus.

Echinus chloroticus, Val., 1846, Voyage Vénus.
Evechinus chloroticus, Verrill, 1871, Notes on adiata.

Kandavu Reef. Fiji Islands.

CLYPEASTRIDA.

Sub-order CLYPEASTRIDÆ, Agass, 1836, Prod. Mon. Rad.

EUCLYPEASTRIDÆ.

Family EUCLYPEASTRIDÆ, Hæckel, 1866, Generelle Morphologie.

FIBULARINA.

Sub-family FIBULARINA, Gray, 1855, Cat. Rec. Echini (*emend.*).

Echinocyamus.

Echinocyamus, Van Phel., 1774, Brief.

Echinocyamus pusillus.

Spatagus pusillus, Müll., 1776, Prod. Zool. Dan.
Echinocyamus pusillus, Gray, 1825, Ann. Phil., p. 6.

Station 122. September 10, 1873. Lat. 9° 5′ S. to 9° 10′ S., long. 34° 49′ W. to 34° 53′ W.; 350, 120, 32 and 400 fathoms in text. (On label simply, Off Barra Grande, St Thomas.)

Fibularia.

Fibularia, Lamk., 1816, Anim. sans Vert.

Fibularia australis.

Fibularia australis, Desml., 1837, Syn., p. 240.

Station 164. June 12, 1874. Lat. 34° 8′ S., long. 152° 0′ E.; 950 fathoms; bottom temperature, 2·2° C.; grey ooze.

Off Port Jackson, 30 to 35 fathoms.

Fibularia volva.

Fibularia volva, Agassiz, 1847, C. R. Ann. Sc. Nat., vol. vii. p. 142.

Station 188. September 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E.; 28 fathoms; mud.

Echinanthidæ.

Sub-family Echinanthidæ, A. Agassiz, 1872, Revis. Ech., part 2, p. 306.

Clypeaster.

Clypeaster, Lamk., 1816, Anim. sans Vert. (Müll., *emend.*).

Clypeaster humilis.

Echinanthus humile, Leske, 1778, Kl. Add., pl. xix. f. A. B.
Clypeaster humilis, A. Agassiz, 1872, Revis. Ech., part 1, p. 100.

Amboyna; 15 to 20 fathoms.

Station 212. January 30, 1875. Lat. 6° 55′ N., long. 122° 15′ E.; 10, 14 and 20 fathoms; sand.

Clypeaster scutiformis.

Echinus scutiformis, Gmel., 1788, Linn. Syst. Nat.
Clypeaster scutiformis, Lamk., 1816, Anim. sans Vert., p. 16.

New Caledonia.

Clypeaster subdepressus (Pl. XXXVIII. fig. 22).

Echinanthus subdepressus, Gray, 1825, Ann. Phil., p. 5.
Clypeaster subdepressus, Agassiz, 1836, Prod.

Off Bahia.

Echinanthus.

Echinanthus, Breyn, 1732, Schediasm (*emend.*).

Echinanthus testudinarius.

Echinanthus testudinarius, Gray, 1851, Proc. Zool. Soc. Lond., p. 35.

Station 163. Trawled (label) in 120 fathoms. Off Twofold Bay. April 4, 1874.
Station 161. April 1, 1874. Off entrance to Port Philip. 38 fathoms; sand.

LAGANIDÆ.

Sub-family LAGANIDÆ, Des., 1857, Synops., p. 217 (*emend.*).

Laganum.

Laganum, Klein, 1734, Nat. Disp. Ech.

Laganum depressum.

Laganum depressum, Less., 1841, in Agassiz, Mon. Scut., p. 110.

Arafura Sea.

Station 187. September 9, 1874. Lat. 10° 36′ S., long. 141° 55′ E.; 6 fathoms; coral sand.

Laganum putnami.

Laganum Putnami, Barn., 1863, in A. Agassiz. Proc. Ac. N. Sc. Phila., p. 359.

Amboyna; 15 to 25 fathoms.

Peronella (*Laganum*).

Peronella, Gray, 1855, Cat. Rec. Ech.

Peronella decagonalis.

Scutella decagonalis, Less., 1827, in Bl., Dict. Sc. Nat. Scut., p. 229.
Peronella decagonalis, A. Agassiz, 1872, Revis. Ech., part 1, p. 148.

Station 186. September 8, 1874. Lat. 10° 30′ S., long. 142° 18′ E.; 8 fathoms; coral sand.

Torres Straits. August 7, 1874.

Amboyna; 15 to 25 fathoms.

Station 212. January 30, 1875. Lat. 6° 55′ N., long. 122° 15′ E.; 10, 14, and 20 fathoms; sand.

Station 190. September 12, 1874. Lat. 8° 56′ S., long. 136° 5′ E.; 49 fathoms; bottom temperature, 23·9° C.; mud.

Tongatabu.

Station 173. July 24, 1874. Lat. 19° 10′ S., long. 179° 40′ E.; 315 to 310 fathoms; coral. Matuku.

Station 188. September 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E.; 28 fathoms; mud.

Station 208. January 17, 1875. Lat. 11° 37′ N., long. 123° 32′ E.; 18 fathoms; mud.

Station 219. March 10, 1875. Lat. 1° 50′ S., long. 146° 42′ E.; 150 fathoms; mud.

Station 192. September 26, 1874. Lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud.

Papeete Harbour, Tahiti, 20 fathoms. September 28, 1875.

Peronella peroni.

Laganum Peronii, Agassiz, 1841, Mon. Scut., p. 123, pl. xxii.
Peronella Peronii, Gray, 1855, Cat. Rec. Ech., p. 13.

Station 162. April 2, 1874. Bass Straits, 38 to 40 fathoms; sand.

Off Port Jackson; 30 to 35 fathoms.

Scutellidæ.

Family Scutellidæ, Agassiz, 1841, Mon. Scut. (*emend.*).

Echinodiscus.

Echinodiscus, Breyn., 1732, De Echin. Schedias. (Leske, *emend.*).

Echinodiscus lævis.

Mellita lævis, Klein, 1734, Nat. Disp. Ech.
Echinodiscus lævis, A. Agassiz, 1872, Revis. Ech., part 1, p. 113.

New Caledonia.

Mellita.

Mellita, Klein, 1734, Nat. Disp. Ech. (*pars.*).

Mellita sexforis.

Echinodiscus sexiesperforatus, Leske, 1778, Kl. Add.
Mellita sexforis, A. Agassiz, 1872, Revis. Ech., part 1, p. 141.

Off Bahia.

Astriclypeus (*Mellita*).

Astriclypeus, Verrill, 1867, Notes on Radiata, p. 311.

Astriclypeus manni.

Astriclypeus Manni, Verrill, 1867, Notes on Radiata, p. 311.

Singisima, Inland Sea, Japan. May 28, 1875.

Encope.

Encope, Agassiz, 1840, Cat. Syst. Ectyp.

Encope emarginata.

Echinodiscus emarginatus, Leske, 1778, Kl. Add., p. 136.
Encope emarginata, Agassiz, 1841, Mon. Scut., p. 47, pl. x.

Off Bahia 20 to 70 fathoms.

PETALOSTICHA.

Sub-order Petalosticha, Hæckel, 1866, Generelle Morphologie (*emend.*).

Cassidulidæ.

Family Cassidulidæ, Agassiz, 1847, C. R. Ann. Sc. Nat., vol. vii. p. 147.

Nucleolidæ.

Sub-family Nucleolidæ, Agassiz, 1847, C. R. Ann. Sc. Nat., vol. vii. p. 147.

Echinolampas.

Echinolampas, Gray, 1825, Ann. Phil.

It certainly is very unfortunate for Paleontological nomenclature that both Gray and myself should have felt compelled to adopt the name *Echinanthus* for *Clypeaster rosaceus.* Desor and D'Orbigny starting from different standpoints, the one in his zeal to restore the old names of Breynius and the other with the idea of not abandoning names of types which had become generally recognised among Echinologists, limited Breynius' genera without any reference to the previous limitations of the same genera suggested by Gray. Gray's suggestions were completely overlooked by Paleontologists, and the confusion which might have been avoided has, I fear, been only increased by these subsequent attempts to reinstate old genera within limits which were not intended by the original author. The limitations originally introduced by Gray, dating back as they do to 1825, have fully as much right to recognition as a similar attempt to reinstate the same old genera within different limits dating from 1855. So that, even granting that it was not worth while to attempt to reinstate the genera of Breynius, it was worth while to take into account the divisions adopted by Gray. But with the insufficient distinctions now shown to exist between *Echinanthus* (fossil) and *Echinolampas*, it may be wisest to retain *Echinolampas* alone for the group now known among Paleontologists as *Echinanthus* and *Echinolampas.*

Echinolampas oviformis (Pl. XXXVII. figs. 10, 11; Pl. XXXIX. fig. 12; Pl. XLI. figs. 9, 10; Pl. XLIII. figs. 3–5; Pl. XLIV. figs. 41–44).

Echinus oviformis, Gmel., 1788, Linn. Syst. Nat.
Echinolampas oviformis, Gray, 1825, Ann. Phil., p. 7.

I have figured on Plate XXXVII. the single specimen of *Echinolampas* collected by the Challenger. It is interesting as it is still covered with spines, while nearly all the specimens of which I have any knowledge are bleached and denuded of spines. The spines are remarkably short over the whole of the abactinal surface, they are distant, slightly swollen at the extremity, and the intertubercular space between the primaries is closely packed by minute slender miliary spines. On the actinal surface the spines are longer and more slender, the miliary spines less numerous; the spines increase in length towards the actinostome and form quite prominent tufts of larger spines over the bourrelets and in the interambulacral spaces adjoining the actinostome.

The colour of the spines in alcoholic specimens is yellowish-green. The general facies of the spines and their arrangement on the test recalls more that of the Clypeastroids (such groups as the Scutellidæ) than the Spatangoids proper.

Station 192. September 26, 1874. Lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud.

Catopygus.

Catopygus, Agassiz, 1836, Prod., p. 185.

**Catopygus recens* (Pl. XX. figs. 17–21).

Catopygus recens, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 204.

Seen from above (Pl. XX. fig. 18) the test is ovoid, being broadest posteriorly; the apical system is anterior, there are three genital pores, the left anterior being wanting; the madreporic body is indistinct. In the petaloid ambulacra the exterior pores are comma-shaped, the interior circular. All the petals are similar in structure, and the anterior and posterior ambulacral petals are equal in length, while the odd anterior is somewhat longer. The median posterior interambulacral suture is sunk in a shallow groove (Pl. XX. fig. 18), which gradually deepens towards the anal system, beyond which it becomes quite deep (Pl. XX. fig. 20) and then gradually comes to the surface of the test at the angle of the round beak, forming the extremity of the anal plastron as is well seen in the end view of the test (Pl. XX. fig. 20). The summit of the test corresponds with the apical system (Pl. XX. fig. 21), the posterior edge of the test is regularly rounded, the anterior extremity forming a rounded point by the junction of the actinal and abactinal curves of the test, where they unite below the extremity of the odd anterior petal. Seen from the end the outline is heart-shaped (Pl. XX. fig. 20) with the rounded anal beak projecting below the level of the actinal surface. The actinal surface is gibbous, with a nearly central slightly sunken actinostome, the phyllodes

are well defined and prominent bourrelets. The anal system is circular, deeply sunken at the extremity of the wide anal groove.

The only specimens of this species collected were denuded of spines. The whole test is covered by a uniform granulation much as in Pl. XX. fig. 17, formed of the primary spines with their sunken areolas, and the intertubercular space is closely covered by minute miliaries; the areolas become less sunken towards the actinostome, and the primaries are also more distant.

The ambulacral pores continue from the petals to the phyllodes in a single row, one pore to each plate placed close to the lower suture (Pl. XX. fig. 17); they are not prominent on the abactinal surface of the test.

Station 192. September 26, 1874. Lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud.

Spatangidæ.

Family Spatangidæ, Agassiz, 1836, Prod. Mon. Rad. (*emend.*).

Pourtalesiæ.

Sub-family Pourtalesiæ, Wy. Thomson, 1877, Voyage of the Challenger, Atlantic, vol. i. pp. 376, 396.

From the analysis given of the characters of the genera allied to *Pourtalesia* proper, it becomes quite evident that we have to deal with a very remarkable group of Echinids, standing in many respects in striking contrast to other Spatangoids, while possessing at the same time affinities to other families of the Petalosticha, and thus showing a close structural relationship hitherto unsuspected between apparently widely different forms. For these reasons it has seemed best to separate this group of Echinids as a new family from the other Spatangoids, and in this I follow the suggestion made by Thomson that these species would probably form a new family characterised by their simple ambulacral system; but as I have shown this character, while well marked in *Pourtalesia*, *Paleopneustes*, *Echinocrepis*, *Cystechinus*, *Aceste*, and the like, becomes less apparent in *Genicopatagus*, *Homolampas* and *Argopatagus*; and such genera as *Aceste* and *Aërope*, are evidently more closely allied to the Brissina than to the Pourtalesiæ, or more properly *Aërope*, is an embryonic *Brissopsis* while *Aceste* is an embryonic *Schizaster*.

The course of the alimentary canal in the Pourtalesiæ seems quite variable. In *Echinocrepis* (Pl. XXXV.[a] fig. 13), after leaving the actinostome the narrow œsophagus opens into a broader alimentary canal, which extends vertically towards the apical system, turns back upon itself over the actinostome curving to the left, then sweeps in a horse-shoe round the edge of the test to the opposite side of the test where it forms a reverse loop to the left (seen from the actinal side) side of the test, and then goes straight to the anal system as a somewhat narrow intestine. The alimentary canal is supported in its place in this genus by a few thin mesenteries, and the two main loops are connected by a broad

mesenteric fold somewhat similar to that of *Rhynchopygus*, but not extending like a diaphragm across the test. In *Spatagocystis*, the course of the alimentary canal (Pl. XXVI.[a] fig. 1) is much the same. It is however more free within the test, and not supported by so many mesenteries. The intestine also opens in the posterior part of the pouch (Pl. XXVI.[a] fig. 5), forming the anal system (Pl. XXVI.[a] fig. 6). In *Pourtalesia* proper, although the anal system is deeply sunken, there is no such pouch formed, the plates of the anal system are nearly on a level with the surface of that part of the test (Pl. XXII. fig. 14; Pl. XXII.[a] fig. 13; Pl. XXVIII.[a] fig. 6; Pl. XXXV.[a] fig. 13). In most of the species of *Pourtalesia* proper, the course of the alimentary canal is still less definite, although having in general the trend of the genera noticed above, as is well shown in the profile views of two specimens of *Pourtalesia hispida* (Pl. XXII. figs. 10, 11), which have the rounded alimentary canal of *Spatagocystis*[1] and no prominent mesenteries. The intestine is well defined in this species (Pl. XXII. fig. 14) as well as in *Spatagocystis* (Pl. XXVI.[a] fig. 6). Hoffman's organ is present in the Pourtalesiæ, and is well shown (Pl. XXII.[a] fig. 12) in *Pourtalesia laguncula*. In *Pourtalesia ceratopyga* we have again the broad alimentary canal well supported on the test by mesenteries, much broader even than we find them in *Echinocrepis*.

The actinostome of the Pourtalesiæ is elliptical, forming the large opening of the actinal groove. It is covered by a membrane strengthened by an outer row of plates (Pl. XXVIII.[a] fig. 9), from the centre of which leads the narrow œsophagus (Pl. XXII.[a] figs. 12, 15); it is not labiate as in *Schizaster* and allied genera, but the structure of the actinostome is more closely allied to that of the Spatangoid genera having the edges of the actinostome in one plane. The structure of the actinal groove is due, as is well seen in a profile view, to the enormous development of the odd anterior ambulacrum, the plates immediately adjoining the actinal edge being fully as large or larger than those of the adjoining interambulacra (Pl. XXII. figs. 15, 17; Pl. XXII.[a] fig. 15; Pl. XXVIII.[a] figs. 9, 11), while those of the anterior lateral ambulacrum are smaller and those of the posterior lateral ambulacra immediately adjoining the actinostome are extremely narrow and elongate (Pl. XXII.[a] figs. 2, 9; Pl. XXVIII.[a] fig. 10; Pl. XXXV.[a] fig. 10; Pl. XXVI.[a] figs. 2, 4). This is of course in entire opposition to the usual structure of the actinal region in Spatangoids, in which owing to the position of the actinostome coincident with the general level of the actinal region and the uniformity of the small size of the plates of the ambulacral areas immediately adjoining the actinal opening as in Plate XXXV. figs. 11, 12, and Plate XXXV.[a] fig. 1, and other normal Spatangoids, no such difference in the size of the ambulacral plates of the different areas exists. The first trace of this gradual increase in size of the plates of the odd ambulacral area is well shown in the genus *Cionobrissus* (Pl. XXIII. fig. 9), in which we have a slight actinal groove. We find the

[1] In *Cystechinus* the course of the narrow alimentary canal is more complicated (Pl. XXIX.[b] fig. 6), recalling somewhat the course it takes in the Desmosticha.

same relative increase in the size of the actinal plates of the odd ambulacrum adjoining the actinostome in all the Spatangoid genera in which there is a tendency to form a more or less distinct actinal groove. In genera allied to the Pourtalesiæ such as *Cystechinus* and *Urechinus*, there is a similar increase in the size of the ambulacral plates round the actinostome (see Pl. XXIX.[a] figs. 15–18; Pl. XXIX.[b] figs. 2, 5, 6; Pl. XXX. fig. 14), but in these genera the actinostome is not vertical but only very slightly sunken below the general level of the actinal surface.

The whole group of Spatangoids to which *Pourtalesia, Echinocrepis, Cystechinus, Urechinus, Calymne,* &c., belong, are remarkable for the large size of the plates of the ambulacral areas (see Pls. XXII.[a], XXVII., XXIX.[b], XXX., XXXV.[a]) compared to the size of the corresponding interambulacral plates.

In *Pourtalesia, Cystechinus, Echinocrepis* and the genera above mentioned there are nearly as many ambulacral as interambulacral plates, and with the exception of a little crowding towards the apical system and at the actinostome, the coronal plates of the two areas alternate nearly as regularly as if they belonged to the same system (see Pl. XXII.[a] figs. 7, 9; Pl. XXVII. fig. 7; Pl. XXIX.[a], XXIX.[b] figs. 1–4; Pl. XXX., XXXV.[a] figs. 9–12, and specially the portions of the ambulacral plates with adjoining interambulacral plate of Plate XXIX.[b] fig. 7; Pl. XXVIII.[a] fig. 14; Pl. XXXV.[a] fig. 8).

In all the Petalosticha with petaloid ambulacra, the number of ambulacral plates is large in the petaloid portion of the ambulacra, and although it decreases, and the plates become larger from the extremity of the petals towards the actinostome, especially on the actinal surface and mainly in the posterior lateral ambulacra, yet they decrease again rapidly when adjoining the actinostome, where two or three or even four ambulacral plates often correspond to a single interambulacral plate of the adjoining area.

In the Clypeastroids the same thing takes place in all those in which we have petaloid ambulacra, while it is in such genera as *Galerites, Discoidea, Hyboclypus* which have not petaloid ambulacra proper that the ambulacral plates are more uniform in size.

It is in the Ananchytidæ, Dysasteridæ, and the like among the Petalosticha that this increase in the size of the ambulacral plates takes place, and it is also among the Dysasteridæ that we find, as in the modern genera allied to *Cystechinus*, the elliptical actinostome only slightly sunken below the level of the actinal region.

All these modern Echinids, however much they resemble the Ananchytidæ and Dysasteridæ in general appearance, and in the structure of their apical system, yet differ radically in having only simple pores for the passage of the ambulacral suckers, piercing each plate near the centre, extending from the abactinal region to the few plates with double pores near the actinostome which carry the so-called gills of the Spatangoids.

In the Petalosticha it is also among the Dysasteridæ that the sunken anal groove makes its appearance in such genera as *Metaporhinus*, and among the Ananchytidæ in *Cardiaster*.

It becomes quite a common feature in many of the genera of the Cassidulidæ and the like; but although it is only in such forms as *Pygurus* and its allies that there is a tendency to form an abactinal anal beak covering the anal system, it is mainly among the Spatangoids that the actinal anal beak appears as a modification of the subanal plastron or an indication of its presence in an exaggerated form such as we have it in *Pourtalesia* proper.

In those Cassiduloid genera in which such a rudimentary actinal beak is formed, the width of the test is generally greatest at the posterior extremity (*Cassidulus*, *Rhynchopygus*). An anal groove is indicated early among the Jurassic and Cretaceous genera in *Pygaster*, *Clypeus*, and *Hyboclypus*, and less distinctly among the Discoideæ and Galeritidæ, and in the latter there is a trace of an abactinal anal snout as in the modern *Echinocrepis* or *Cystechinus*, and *Urechinus*, while a true actinal groove, although indicated in *Dysaster* and perhaps in *Asterostoma* where all the actinal ambulacra are sunken, is well seen in the Ananchytidæ and especially in *Infulaster*, which by its abnormal outline recalls to us strikingly the Pourtalesian genus *Echinocrepis*.

The absence of a fasciole in such genera as *Echinocrepis* and *Cystechinus*, and the presênce of a distinct anal fasciole in *Pourtalesia* and *Urechinus*, plainly shows that in the Petalosticha the earliest fasciole to appear was probably a subanal one, as it seems to exist in such genera as *Urechinus* in which the anal snout exists in a very rudimentary form, and in which the subanal shield (Pl. XXX. fig. 19) is quite faintly indicated.

The subanal fasciole of such Cretaceous genera as *Cardiaster* and *Micraster*, in which it first makes its appearance among the fossils, would seem to bear out this view.

In *Pourtalesia* proper I have in the description of the species called attention to the structure of the apical system, and shown that the four genital plates are with one exception in the trivium; and this is well separated from the bivium by the intercalated apical interambulacral plates. In *Cystechinus* the separation is different, two of the genital plates (Pl. XXXV.[a] fig. 5) are associated with the bivium and two with the trivium, and the bivium and trivium are separated by the intercalated apical interambulacral plates. The same is the case with *Urechinus* (Pl. XXX. figs. 16, 17).

In *Echinocrepis*, however, as in *Pourtalesia rosea*, the genital plates are contiguous, and the bivium and trivium are not separated, while in *Spatagocystis* the apical system is like that of *Pourtalesia* proper; the genital plates are connected with the trivium (Pl. XXVI.[a] fig. 8), and that is separated from the bivium by the intercalated apical interambulacral plates.

The many differently shaped species of the genera of Pourtalesiæ take their outline from the greater or less development of the different ambulacral and interambulacral regions. The high and short ambulacral and interambulacral coronal plates, nearly of uniform size, of the anterior portion of the test, combined with a moderate elongation of the posterior lateral ambulacra and interambulacra, give us such forms as *Pourtalesia laguncula*, *Pourtalesia jeffreysi*, and *Pourtalesia miranda;* with lower coronal plates in the

anterior region we get forms like *Pourtalesia carinata.* With these lower anterior coronal plates, combined with a great elongation of the plates, especially of those of the posterior lateral, interambulacral, and ambulacral areas, we get such forms as *Pourtalesia phiale,* while with plates of a uniform size in the different parts of the test we get such conical forms as *Echinocrepis,* and when more or less elongate posteriorly, such forms as *Pourtalesia ceratopyga* by the elongation of the posterior plates.

In *Spatagocystis* the arched elliptical test is the result of a large number of horizontally elongated coronal plates, somewhat larger in the posterior region of the test and of uniform size anteriorly, while the more regular outline of *Urechinus* is the result of a greater uniformity in the size of the plates of the anterior and posterior extremities, which reaches its maximum of regularity in the nearly circular outline of *Cystechinus* with its ambulacral and interambulacral areas composed of plates nearly all of uniform size in corresponding parts of the test.

The genus *Echinocrepis* seems to form a passage between the Pourtalesiæ without an anal snout and such Ananchytid genera as *Cystechinus.* We readily trace also how such genera as *Nucleolites* do not differ so radically as they seem to do at first sight from genera in which the anal groove is not developed. In fact when we compare the fossil genera *Echinobrissus, Hyboclypus, Clypeopygus,* and the like, with the Pourtalesiæ, we find in the latter family a sunken actinal groove, a feature once so common among the genera of the Jurrassic and Cretaceous periods. This structure has become less and less common until we find but few genera in the Tertiary formation with a sunken anal groove, and at the present time only a few species of *Nucleolites* in addition to the Pourtalesiæ still retain the sunken anal groove. This seems in the Secondary and Tertiary periods to have been a character peculiar to the Echinolampadæ and their allies. The existence of a deeply-sunken actinal groove or its representative is, however, much more prevalent among the recent Spatangoids, and its modification from the simple sunken ambulacrum of *Asterostoma* to the deeply-sunken actinal groove of *Pourtalesia* can be easily traced. It has left its trace in the greater number of recent Spatangoids in the more or less sunken anterior ambulacral groove. This, however, in most recent Spatangoid genera is limited to the abactinal side of the test, generally disappearing at the ambitus, taking its greatest development in the deeply-sunken ambulacra of some of the Schizasteridæ such as *Moira* and *Schizaster,* and forming a gradual transition, as it were, between the existence of a single deeply sunken anterior ambulacral groove situated on the actinal side and the more or less sunken petaloid ambulacra. That is to say, the actinal groove is a modification at the actinal region of the ambulacra similiar to the sinking of the plates of the apical part of the ambulacra to form more or less deeply sunken areas; only the pores remain single, and there is no modification of the pores forming the petals, indicating a different function, as in the normal Spatangoids.

In the normal Spatangoids the odd interambulacrum on the actinal surface consists generally of three large plates, which occupy the whole space between the actinostome and the edge of the ambitus. In the Pourtalesiæ and the allied genera, *Spatagocystis*, *Echinocrepis*, *Cystechinus*, and *Urechinus*, this odd interambulacrum is made up of a large number of small plates, none of them having the preponderance in size so marked in the majority of recent Spatangoids and forming the well-marked actinal plastron of such genera as *Schizaster*, *Maretia*, *Metalia*, *Hemiaster*, &c. It is in genera like *Palæotropus* and *Genicopatagus* that the actinal plastron has a somewhat greater prominence till it becomes in such types as *Homolampas*, *Paleopneustes*, and *Argopatagus* nearly as prominent as in the Spatangoids proper mentioned above. This character of the absence of a true actinal plastron is characteristic of the Petalostichan genera which retain Clypeastroid[1] or Echinolampan features, and we find it, consequently, wanting in such families as the Cassidulidæ and Dysasteridæ, while in the Ananchytidæ the actinal plastron is a prominent structural feature of the family which gradually becomes more marked in the other families of Spatangoids.

The genus *Spatagocystis* forms the passage between such genera as *Holaster*, *Cardiaster*, *Ananchytes*, *Infulaster*, and *Pourtalesia*. From above it has somewhat the general outline of the pointed form of *Pourtalesia laguncula*, while the test has the general appearance of *Cardiaster* and *Ananchytes* combined with the sunken actinostome of *Pourtalesia* and the presence of a small anal snout, with the slightly sunken anterior ambulacral region of *Infulaster*; while *Echinocrepis* forms the passage from the Pourtalesiæ to such Ananchytid forms as *Cystechinus* and *Urechinus* so far as the structure of the anal system is concerned. The test of *Spatagocystis* has neither the angular outline of *Echinocrepis* nor the bottle form of *Pourtalesia*, but has the swollen rounded contour of Spatangoids like *Micraster* and *Holaster*.

The anal snout formed in *Spatagocystis* resembles more the beak in prolongation of the subanal plastron of some of the Spatangoid genera, such as *Echinocardium* and the like. With the overhanging abactinal hood and the small beak of *Spatagocystis* we readily trace the passage to such an anal extremity as that of *Urechinus* and *Echinocrepis*, in which the actinal slope forms a more or less bevelled surface with rounded angles to the actinal and abactinal surfaces, on which is situated the more or less sunken anal system. The prominence of the anal snout plays an important part in deflecting the odd interambulacrum from its course, or in stopping it even altogether from reaching the actinal surface or disconnecting it from the actinal plastron.

In the group of Spatangoids to which we now come, the genera *Argopatagus*, *Homolampas*, *Genicopatagus*, *Linopneustes*, and *Paleopneustes*, while having for a part of the

[1] The Clypeastroid affinities of the Pourtalesiæ consist in the simple actinostome and in the structure of some of the pedicellariæ which are like those of the Clypeastroids and Echinolampadæ.

ambulacra the simple ambulacral pores characteristic of the genera of the Pourtalesiæ proper, such as *Pourtalesia, Echinocrepis, Cystechinus, Urechinus*, and *Calymne*, differ from these in having either a labiate actinostome similiar to that of the normal Spatangoids, or in having a lateral fasciole in addition to the more or less rudimentary subanal fasciole found in the latter group. This second group also shows a tendency in the abactinal region to form rudimentary petals, but in these the tentacles, while passing through pairs of pores, still retain the simple character found in the Pourtalesiæ proper.

In *Aërope* and *Aceste* the odd anterior ambulacrum takes a great development, the suckers of that area occupying in one genus the greater part of the abactinal surface within the peripetalous fasciole; in the other the whole of the same space in the sloping anterior part of the test. This group of Spatangoids brings out the affinities of the Pourtalesiæ to such Spatangoids as *Brissopsis, Hemiaster, Echinocardium, Lovenia*, and the like.

The group of Spatangoids to which *Argopatagus, Homolampas*, and *Paleopneustes* belong, although it has the highly labiate actinostome so characteristic of the recent Spatangoids, is characterised by the rudimentary nature of the ambulacra and by the embryonic structure of the ambulacral and interambulacral plates, that is to say, by their uniformity in size. This is specially the case in *Argopatagus* and *Genicopatagus*, somewhat less in *Paleopneustes*, while in *Homolampas* the great difference in the size of the plates composing the ambulacra and interambulacra brings this genus nearer the typical Spatangoid in structure; in *Paleopneustes*, the closer relationship is indicated by the tendency to form more or less rudimentary petaloid ambulacra towards the apical system.

Aërope and *Aceste*, together with *Cionobrissus*, form a group of Spatangoids illustrating the affinities of the family Pourtalesiæ with the Brissina. In *Aërope* and *Aceste* the actinal surface of the test, while having the normal Spatangoid structure of a more or less well-developed actinal plastron, yet retains somewhat the cylindrical form of the Pourtalesiæ and the simple circular actinostome of this family. The ambulacral system, although more simple than in *Cionobrissus*, is surrounded by a more rudimentary, less distinctly defined peripetalous fasciole; and we have no trace of any anal snout which is still a prominent feature in *Cionobrissus*, and very rudimentary in the Brissina proper. The sunken odd ambulacrum of *Aceste*, the great development of the suckers of this ambulacrum in both *Aërope* and *Aceste* is a feature with which we had become familiar in young Brissina. The presence of a large anal fasciole surrounding the posterior part of the test is likewise a feature characteristic of the young of that family. In *Cionobrissus* the petaloid system is as greatly developed as in such genera as *Brissopsis* and *Macropneustes*. The affinities developed in so many directions in the group of Pourtalesiæ is one of its most interesting features; and as we have just traced the relationship of the Pourtalesiæ to the Brissina, and to such genera as *Hemiaster, Echinocardium, Lovenia*,

and the like through *Aërope*, *Aceste*, and *Cionobrissus*, we can as readily trace the affinities of the family to the Spatangina proper through such genera as *Palæotropus*, *Genicopatagus*, and *Homolampas*, and again to the Galeritidæ and Echinolampadæ through such genera as *Urechinus* and *Cystechinus*, while the many-sided affinities of the Pourtalesiæ to the Ananchytidæ, Dysasteridæ, and such genera as *Cardiaster*, *Holaster*, *Toxaster*, and the like have been more or less insisted upon in the comparative description of the several genera of the family.

The fact that this group of Pourtalesiæ has existed undisturbed since the Chalk, and has been modified in so many different directions, makes this family one of the most interesting studies among the Echinids as far as relates to the affinities of the different groups of Spatangoids; and their examination has done much to bring out the close relationship existing between apparently most distant forms in the study of the fossil genera thus far discovered ranging from the Chalk to the present time.

The Ananchytid and at the same time the Galeritid affinities of the family are best shown in the structure of *Cystechinus*, in which we have a slightly sunken actinostome, no fascioles, a disconnected apical system, the plates of the test of nearly equal size in the ambulacra and interambulacra, a flat actinal region, a high conical test, and in some species a tendency in the plates surrounding the actinostome to develop into bourrelets or into an indistinct posterior labium. Such a genus as *Urechinus*, on the other hand, although most closely allied to *Cystechinus*, strikingly shows much more normal Spatangoid affinities; and such a genus as *Calymne*, while retaining structural features of *Cystechinus*, such as the uniform size of the coronal plates in all the areas, has an elliptical test, a strongly-marked actinal keel, again a most Ananchytid apical system, simple ambulacral pores, a circular actinostome, and on the other side, the rudiments of a peripetalous fasciole across the anterior extremity, a feature only found in those Spatangoids differing most widely from such genera as recall the Echinolampadæ or Clypeastroids.

Through *Homolampas* and *Argopatagus*, which at first glance so greatly resemble *Spatangus* proper, we can readily trace the relation of the Pourtalesiæ to the Spatangina. The simple ambulacral pores, the rudimentary petals, and the comparatively large ambulacral plates are Pourtalesian features, while the structure of the actinal surface, the presence of a subanal and peripetalous fasciole (in *Homolampas fulva*), the great development of some of the primary tubercles, and the prominently labiate actinostome, place this genus in close proximity to such genera as *Lovenia*, *Maretia*, *Eupatagus*, and *Metalia*.

Genicopatagus, on the contrary, shows most markedly the affinities of the family to Spatangoids with a prominent labiate actinostome; to such genera as *Holaster*, *Cardiaster*, and *Toxaster* the group becomes allied from the structure of the ambulacral areas above the ambitus; while the remarkable affinities of this genus to *Paleopneustes* and *Palæotropus*, from the structure of the ambulacral petals, as well as the total absence of fas-

cioles, and the large size and small number of the coronal plates in both areas, both on the actinal and abactinal sides of the test, also show the structural affinities in the direction of the Ananchytidæ and Galeritidæ.

It is remarkable that it is among the Dysasteridæ[1] to which the Pourtalesiæ are in many respects most closely allied, that we also find a very great diversity in the outline of the test; many species of the Collyritidæ, such as *Dysaster calceolatus*, resemble closely our recent *Echinocrepis;* others, like *Collyrites jaccardi*, Des., remind us of *Urechinus.* On the other hand such genera as *Archiacia*, *Infulaster*, *Grasia*, and *Metaporhinus*, among the extinct genera, show quite as great diversity in shape as we find between *Pourtalesia*, *Cystechinus* and *Spatagocystis* among the deep-sea types of Pourtalesiæ.

It is interesting to note the general character of the pedicellariæ. Among the numerous genera of Pourtalesiæ there is no group of Echinids in which we find so many different kinds, and their structure like that of the spines and of the different parts of the test points to the most varied systematic affinities. We find among these the large-headed pedicellariæ (Pl. XLV. fig. 48) of *Pourtalesia* (Pl. XLV. figs. 28, 36), of *Cystechinus*, of *Spatagocystis* (Pl. XLV. fig. 39), of *Genicopatagus* (Pl. XLV. fig. 21), the type of Spatangoid pedicellariæ which most closely resembles that of the large-headed pedicellariæ of the Echinidæ and Echinometradæ.

We next find the Spatangoid type (Pl. XLV. figs 20, 20′) which in this group seems frequently modified to assume the more Echinid-like type, of which *Pseudoboletia* is an example (Pl. XLIV. fig. 38), of having one or two large hooks terminating the more or less narrow prong of the valves as in *Pourtalesia* (Pl. XLV. figs. 46, 47, 49, 56, 57, 58). Or else we have the extremity of the valves varying from the Spatangoid type in becoming more or less cup-shaped (Pl. XLV. fig. 41) with strong serrations (Pl. XLV. fig. 43, *Echinocrepis*) approaching somewhat the regular crescentic serrations so characteristic of the Clypeastroids, and which is still more markedly Clypeastroid in *Aceste* (Pl. XLIV. fig. 47). In *Cystechinus*, and specially in *Pourtalesia* proper, these Clypeastroid like pedicellariæ are very characteristic of the type and indicative of one of the most interesting of the affinities of this Spatangoid group of Echinids, an affinity fully borne out by a comparison of other structural features. It is specially interesting to note in this connection that in *Echinolampas* (Pl. XLIII. figs. 3, 4; Pl. XLV. figs. 41, 43) these Clypeastroid like pedicellariæ also occur.

Pourtalesia.

Pourtalesia, A. Agassiz, 1869, Bull. Mus. Comp. Zool., vol. i.

In the genus *Pourtalesia* proper, as I have retained it here, there are two groups of species readily distinguished from the character of the test; these I was at first inclined

[1] The spines of the Dysasteridæ, which have been figured by Ooster and De Loriol, are similar to those of the Pourtalesiæ.

to separate into distinct sub-genera on comparing such extreme forms as *Pourtalesia miranda*, *P. laguncula*, and *P. phiale* with such forms as *Pourtalesia ceratopyga* and *P. rosea*. The former group is distinguished by the extreme tenuity, almost transparency, of the test and its more or less bottle-shaped outline, while the latter group contains species with a flattened test, a triangular outline from above and a comparatively thickened test.

On examining, however, the group of Pourtalesiæ to which *Pourtalesia hispida*, *P. carinata*, and *P. jeffreysi* belong, the impossibility of maintaining this arbitrary division becomes at once apparent.

Pourtalesia hispida, while having the general appearance of *Pourtalesia miranda*, has a much thicker test, and in *Pourtalesia carinata* we have a stout test and a prominent snout, with a posterior apex, and the closer tuberculation of the group to which *Pourtalesia rosea* and *P. ceratopyga* belong. It is remarkable how great is the variation in the extent of the separation of the bivium and trivium at the apical system in the different species of the genus.

In *Pourtalesia rosea* the genital plates join the ocular plates of the bivium (Pl. XXII.[a] fig. 6), in *Pourtalesia laguncula*, *P. hispida*, *P. ceratopyga*, *P. carinata* and *P. jeffreysi* the plates of the posterior lateral interambulacra extend entirely across between the bivium and trivium, completely separating them (Pls. XXII. fig. 19; Pl. XXII.[a] fig. 10; Pl. XXVIII. figs. 11, 12; Pl. XXVIII.[a] fig. 12).

I have to add as one of the generic characters of *Pourtalesia* the existence of a well-developed subanal fasciole, which in some of the species forms a broad band round the anal snout.

**Pourtalesia carinata* (Pls. XXVII.[a], XXXVIII. figs. 30, 31; Pl. XLI. figs. 49–52; Pl. XLII. figs. 24, 25; Pl. XLIII. figs. 20–23; Pl. XLV. figs. 46–52).

Pourtalesia carinata, A. Agassiz, Proc. Am. Acad., vol. xiv. p. 205.

This is a large species with a comparatively stout test. It resembles in outline *Pourtalesia miranda*, but is more gibbous, with a more regularly-sloping anterior extremity (Pl. XXVIII.[a] fig. 2), which brings the apex more posteriorly than in that species. The greatest breadth of test seen from above is also more posterior (Pl. XXVIII.[a] fig. 1). The primary spines are more numerous on the median interambulacral line of the abactinal side of the test on the anterior and on the odd interambulacra. The rest of the test is quite thickly covered with small secondary spines increasing in size towards the ambitus, and on the actinal side the keel of the plastron carries still larger primary spines on tubercles closely packed on the ridges of the line of the actinal keel (Pl. XXVIII.[a] fig. 8), and also crowded on the actinal part of the anterior interambulacra and on the interambulacral plate near the anal snout (Pl. XXXVIII.[a] figs. 3, 4). The greatest height of the test is posterior, the apex not corresponding with the apical system. The subanal fasciole

is regularly marked and rather narrow (Pl. XXVIII.[a] figs. 3, 4). The primary spines are only slightly curved and flaring, generally uniform in width on the sides, but below flaring and club-shaped. There are four well-marked genital pores (Pl. XXVIII.[a] fig. 12) situated in the trivium, which is well separated from the bivium. The genital organs are short clusters (Pl. XXVIII.[a] fig. 13) of from seven to eight large purse-like pouches, which do not apparently ramify like the ovaries of *Pourtalesia laguncula.* The madreporic body is insignificant.

This species, while having the outline of *Pourtalesia miranda, P. laguncula,* and *P. jeffreysi,* has the stout test and close tuberculation of *Pourtalesia ceratopyga.* The actinal groove is comparatively smaller, shallower, and narrower than in those species, and the slight re-entering angle formed by the anterior extremity when seen from above, and the more sloping anterior extremity form a passage between the bottle-shaped forms like *Pourtalesia miranda,* and the triangular types with posterior apex like *Pourtalesia ceratopyga.*

The actinal and abactinal lines of the snout are nearly parallel, forming a sharp angle at the abactinal extremity. The anal groove is short and deeply indented. Judging from the size of some of the fragments of the test of this species, it must have attained a length to from 90 to100 mm.

The colour of the test in alcoholic specimens is of a light claret, the whitish-pink spines standing out in relief upon the dark background. The colour of the test is often darker on the abactinal keel and on the anterior median interambulacral ridges of the abactinal side of the test.

Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E.; 1600 fathoms; bottom temperature, 0·8° C.; globigerina ooze.

Station 157. March, 3, 1874. Lat. 53° 55′ S., long. 108° 35′ E.; 1950 fathoms; diatom ooze.

Station 298. November 17, 1875. Lat. 34° 7′ S., long. 73° 56′ W.; 2225 fathoms; bottom temperature, 1·3° C.; grey mud.

**Pourtalesia ceratopyga* (Pls. XXVIII. XXXV.[b] fig. 17; Pl. XLI. figs. 44–46; Pl. XLII. figs. 17–23; Pl. XLIII. figs. 15–17; Pl. XLV. figs. 53–59).

Pourtalesia ceratopyga, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 205.

Nearly complete specimens of a large *Pourtalesia* which were brought up from 2225 fathoms at Station 298, form, with *Pourtalesia rosea,* an entirely distinct group from the other species collected. This species is remarkable for the great breadth (Pl. XXVIII. fig. 1) of the anterior extremity, with the re-entering median ambulacral region extending laterally so as to form a rounded angle with the sides; this part of the test is by far the widest, and it slopes very rapidly towards the posterior extremity. The width of the anal snout is proportionally smaller than in the other species of the group; the sunken actinal

groove is narrow, and the actinostome not very distant from the anterior edge; the test is comparatively low (Pl. XXVIII. fig. 2), with a large number of primary tubercles quite uniformly scattered over it (Pl. XXVIII. fig. 10), except along the actinal keel where they are somewhat larger (Pl. XXVIII. fig. 7). The test is thin but hard and solid, the subanal fasciole is large and broad (Pl. XXVIII. figs. 5, 7), and the number of plates comprised in the test is greater than in other species. The spines of this species are proportionally short and stouter than in the other species of the genus. The whole test is moderately covered with small secondary and miliary spines.

There are four genital openings, three larger than the fourth (the left anterior), which is quite rudimentary; they are situated in the trivium, well separated from the bivium by the lateral ambulacral plates (Pl. XXVIII. fig. 12). The anal snout is seen in profile (Pl. XXVIII. fig. 2.), angular, separated from the test on the abactinal side by a deep, sharp cut. The test seen in profile is quite flattened (Pl. XXVIII. fig. 2), regularly arching anteriorly, the actinal curve slightly re-entering at the actinostome and convex again towards the anal snout, the abactinal curve very slightly arched towards the posterior extremity, suddenly falling towards the deep notch separating the anal snout from the posterior part of the test.

The apex and apical system are not coincident, the apex being posterior and the apical system anterior. Immediately adjoining the actinal groove the anterior part of the actinal surface is quite flat (Pl. XXVIII. figs. 6, 8). Seen from the anal extremity the outline is triangular with rounded angles (Pl. XXVIII. fig. 4), with a slight posterior actinal keel (Pl. XXVIII. fig. 7) to which the anal snout is joined like a button. The outline when seen from the anterior end is also triangular, but with a re-entering angle gradually sloping from the flattened anterior actinal surface to the sunken actinal groove (Pl. XXVIII. fig. 3). The specimens in alcohol were of a dark claret colour at first, but they have gradually faded out to a light violet tint.

The largest specimen collected measured 98 mm. in length, but fragments of the anterior extremity of the test indicate that this species must attain nearly double that length.

Both this species and *Pourtalesia rosea* are characterised by the absence of prominently-marked keels, formed by the concentration of primary tubercles on the abactinal median interambulacral space of the lateral anterior ambulacra and of the posterior abactinal interambulacrum.

Station 157. March, 3, 1874. Lat. 53° 55′ S., long. 108° 35′ E.; 1950 fathoms; diatom ooze.

Station 298. November 17, 1875. Lat. 34° 7′ S., long. 73° 56′ W.; 2225 fathoms; bottom temperature, 1·3° C.; grey mud.

Station 299. December 14, 1875. Lat. 33° 31′ S., long. 74° 43′ W.; 2160 fathoms; bottom temperature, 1·1° C.; grey mud.

Pourtalesia hispida (Pl. XXII. figs. 6–19; Pl. XXXIX. figs. 34, 36; Pl. XLI. figs. 47, 48).

Pourtalesia hispida, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 204.

This species mainly differs from its nearest ally, *Pourtalesia jeffreysi*, Wy. Thomson, in having a shorter anal snout, a more flattened actinal surface, a smaller actinal plastron, and a smaller number of larger primary tubercles arranged in horizontal rows across the primary plates. Its outline is more rectangular anteriorly, and more nearly vertically truncated.

Seen from above (Pl. XXII. fig. 7), the sides of the test are nearly parallel, with very slightly re-entering sides, the anterior edge of the test is at right angles with the sides, and the posterior part of the test is conical with a small rounded snout.

The primary spines are arranged in distant rows of three or four along the sides of the test (Pl. XXII. fig. 6); they are quite short, stout, sharp, more crowded along the abactinal keel, and are still more numerous immediately above the anal system (Pl. XXII. figs. 7, 9, 12). The anterior slope of the test carries small closely-packed miliaries (Pl. XXII. fig. 13), except on the edge and in the deeply-sunken actinal groove where the spines are large and closely packed (Pl. XXII. fig. 8), extending across the actinal groove on the actinal side. The primary spines are also more numerous on the rounded keel formed by the anterior interambulacral areas (Pl. XXII. fig. 8), and most closely packed on the small actinal plastron. The rest of the broad flat actinal surface carries distant irregularly-arranged primary spines. The rest of the test carries but few miliaries or secondaries. Seen in profile the anterior extremity is nearly vertically truncated and rounded anteriorly, the apical system and apex corresponding. The line of the actinal surface is nearly flat, curving upwards to form the lower edge of the anal snout. The abactinal line is also regularly arched, but falls suddenly above the anal opening and is indented where it forms the abactinal line of the anal snout (Pl. XXII. fig. 6, 9). This is less developed than in any other species of the genus *Pourtalesia.* The subanal fasciole is not clearly defined, it extends round the sharp anal snout as a broad band of miliaries with ill-defined edges, both exterior and interior.

Seen from the anal extremity, the anal system is placed in a deep triangular pit with rounded sides (Pl. XXII. fig. 12).

There are in this species four genital openings (Pl. XXII. fig. 19), each connected with a well-developed genital pouch (Pl. XXII. fig. 18). The four genital openings are situated in the trivium (Pl. XXII. fig. 19), and this is well separated from the bivium by supplementary interambulacral plates. In alcohol the colour of the test is of a greyish-pink, the spines of a lighter tint; at the base of the spines the test is of a darker colour forming a deep patch which extends to the miliary ring. Both in this species and in *Pourtalesia phiale*, the primary spines are comparatively short, sharp, and stout, and are quite regularly arranged over the surface of the test.

The sunken actinal system is proportionally larger, the actinal plastron is flatter, and when seen in profile the test is not as distinctly keeled above and below as in *Pourtalesia miranda.*

Pourtalesia miranda, P. laguncula, P. jeffreysi, and *P. hispida,* as well as *P. phiale,* are characterised by an extremely delicate, thin, and more or less transparent test; in these species we have the outline of the test passing from that of an elongate bottle-shape to a rectangular form with round corners and a pointed extremity, then to a triangular flattened test with a prominent anal snout, as in the group to which *Pourtalesia rosea* and *P. ceratopyga* belong, till we come to the typical *Echinocrepis* on the one side, or pass on the other hand through the more globular and cylindrical forms such as *Pourtalesia carinata* to *Spatagocystis* and finally to *Cystechinus.*

The largest specimens collected, judging from some fragments, must have measured 55–60 mm. in length; the smallest about half that length.

Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E.; 1600 fathoms; bottom temperature, 0·8° C.; globigerina ooze.

Station 156. February 26, 1874. Lat. 62° 26′ S., long. 95° 44′ E.; 1975 fathoms; diatom ooze.

**Pourtalesia laguncula* (Pl. XXII.[a] figs. 7–15; Pl. XXXI. figs. 1–11; Pl. XXXIX. fig. 35; Pl. XL. figs. 61, 62; Pl. XLI. fig. 53; Pl. XLIII. figs. 18, 19).

Pourtalesia laguncula, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 205.

This species is closely allied to *Pourtalesia miranda*; it is, however, more bottle-shaped (Pl. XXXI. figs. 1, 2), comparatively broader at the anterior extremity, shorter, with a wide anal snout, and a more vertically truncated anterior extremity (Pl. XXXI. fig. 3), a shorter actinal plastron with larger primary tubercles and a very broad fasciole round the anal snout (Pl. XXII.[a] figs. 7, 9; Pl. XXXI. fig. 4). This fasciole I did not detect in *Pourtalesia miranda,* and as the unique specimen is in the hands of Professor Lovén at this moment of writing, I am unable to give its position, which in the drawing (Revis. Ech., pl. xviii. figs. 6, 7), seems to run more on the abactinal side of the snout towards the anal system than in this species. On the actinal surface (Pl. XXXI. fig. 1) the primary tubercles are few in number, distant, and extend on the sides of the test mainly towards the anterior extremity (Pl. XXXI. fig. 1), from the ambitus to the apical system; there are from two to three to each plate (Pl. XXII.[a] figs. 7, 9). The primary spines are generally slightly curved, cylindrical, tapering very slightly or club-shaped, more thickly crowded in the actinal groove. The whole test is more or less thickly covered by minute club-shaped miliary spines.

The ambulacral tentacles of the odd ambulacrum are large, thick (Pl. XXXI. figs. 2, 6), pointed, and quite prominent from the apex until they pass into the actinal groove.

In nearly all the specimens which were broken, so as to admit of a view of the interior

of the test, the genital organs are well developed, the long genital glands (Pl. XXII.[a] fig. 14) branch into fine ramifications extending far towards the anal extremity.

In alcohol the colour of the test of this species is light violet or ash coloured, becoming quite dark towards the abactinal keel and along the anal plastron, as well as at the anterior extremity.

The younger specimens of this species show considerable variation in the outline (Pl. XXXI. figs. 7–9). They are more triangular when seen from above, less bottle-shaped, the anal snout more pointed, and when seen in profile (Pl. XXXI. figs. 10, 11) the snout is not yet separated from the test by the deep re-entering angle so marked in older stages. The actinal groove is also proportionally much wider and larger. Seen from the actinal or anal end (Pl. XXXI. figs. 5, 6), the outline is much less heart-shaped than in *Pourtalesia miranda*, the rounded outline of the actinal surface projecting further beyond the general level of the test than in *Pourtalesia miranda*. The younger stages of *Pourtalesia laguncula* resemble somewhat *Pourtalesia phiale*, in which the anal snout is remarkable on account of its closer connection with the anal part of the test, compare Plate XXXI. figs, 7–9 with Plate XXII.[a] figs. 1, 2.

In *Pourtalesia hispida* we have also a somewhat pointed anal snout, but much shorter than in the young specimens of *Pourtalesia laguncula*, the proportions of the anal snout and its mode of connection with the posterior extremity of the test seem subject to very considerable variations; some of the specimens with narrow anal snout characteristic of the smaller specimens measuring from 12–16 mm. were nearly 19 mm. in length. This is quite a small species, the largest specimen measuring only from 22–25 mm.

Station 191. September 23, 1874. Lat. 5° 41′ S., long. 134° 4′ E.; 800 fathoms; bottom temperature, 3·9° C.; mud.

Station 168. July 8, 1874. Lat. 40° 28′ S., long. 177° 43′ E.; 1100 fathoms; bottom temperature, 2·0° C.; grey ooze.

Station 169. July 10, 1874. Lat. 37° 34′ S., long. 179° 22′ E.; 700 fathoms; bottom temperature, 4·2° C.; grey ooze.

Station 232. May 12, 1875. Lat. 35° 11′ N., long. 139° 28′ E.; 345 fathoms; bottom temperature, 5·0° C.; sandy mud.

Station 244. June 28, 1875. Lat. 35° 22′ N., long. 169° 53′ E.; 2900 fathoms; bottom temperature, 1·2° C.; red clay.

Pourtalesia phiale (Pl. XXII. figs. 1–5; Pl. XXII.[a] figs. 1, 2).

Pourtalesia phiale, Wy. Thomson, 1873, Depths of the Sea, p. 90; Trans. Roy. Soc., 1874, vol. clxiv., part 2, p. 749, pl. lxx. fig. 11.

Thomson has only given a very short description of this species in the Echinoidea of the "Porcupine" Expedition.[1] I have given on Plate XXI.[a] figs. 1, 2, two figures of this

[1] Wyville Thomson, 1874, Trans. Roy. Soc., vol. clxiv., part 2, p. 749.

species, showing the great elongation of the plates of the test which give it its peculiar appearance. The subanal fasciole is broad, well-marked, and the actinal groove a rather shallow triangularly shaped depression with steep sides (Pl. XXII.[a] fig. 2). In general outline it resembles a very elongated *Pourtalesia miranda*, and I was at first inclined to regard it as the young of that species. The young specimens of *Pourtalesia laguncula* collected by the Challenger, seem, however, to leave no doubt regarding the distinct specific characters of this species. Seen endwise, the outline of the test is nearly elliptical (Pl. XXII. figs. 4, 5) from the two prominent actinal and abactinal keels, which project beyond the general level of these surfaces. Seen from the actinal end (Pl. XXII. fig. 4), the actinal groove occupies nearly the whole of the section of the test. As in *Pourtalesia laguncula* the primary spines are irregularly scattered over the test, and are not specially crowded along the abactinal ridge. The apex of this species is posterior (Pl. XXII. fig. 2; XXII.[a] fig. 1), and it is remarkable also for its convex actinal surface, so shaped that the greatest convexity is about half-way from the anal snout to the anterior end. Seen from above, the anterior extremity has more the shape of that of such Pourtalesiæ as *Pourtalesia ceratopyga*, but is remarkable for the great size of the actinal grove which forms a huge triangular depression (Pl. XXII.[a] fig. 2; Pl. XXII. fig. 1), occupying the whole anterior extremity of the test, on the somewhat flattened actinal surface. The anal snout is also somewhat more flattened than in the other species of Pourtalesiæ, more as we find it in *Pourtalesia rosea*. The outline of the test, when seen from the actinal side is bottle shaped, with deeply convex sides near the anterior extremity (Pl. XXII. fig. 1; Pl. XXII.[a] fig. 2), widest about half-way between the anterior extremity and the snout, and gradually sloping towards the posterior extremity. The abactinal surface slopes very gradually from the apex towards the anterior extremity, forming a slightly concave line before reaching the anterior edge. It slopes quite abruptly towards the level of the anal snout (Pl. XXII.[a] fig. 1). Both the actinal and abactinal keels of this species are quite prominent (Pl. XXII. figs. 1, 3). The excessive elongation of the odd interambulacral end of the lateral posterior interambulacral and ambulacral areas, gives to this species its greatly elongated shape (Pl. XXII.[a] figs. 1, 2).

Pourtalesia phiale seems to be a comparatively small species; the specimen collected by the Challenger measured 18 mm. The test is extremely thin. In alcohol it is of a light yellowish-pink colour, the spines of a darker tint.

Station 156. February 26, 1874. Lat. 62° 26′ S., long. 95° 44′ E.; 1975 fathoms; diatom ooze.

**Pourtalesia rosea* (Pl. XXII.[a] figs. 3–6).

Pourtalesia rosea, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 206.

Fragments of a delicate pinkish *Pourtalesia* were brought up from Station 272; they must have belonged to a large species closely allied to *Pourtalesia ceratopyga*, and

probably as large. It differs from that species, however, in having an anal snout (Pl. XXII.[a] figs. 3–5) not so well separated from the test as in *Pourtalesia ceratopyga* and other Pourtalesiæ, but much like that of *Pourtalesia phiale*, only the fasciole extends from the anal surface on the edge of the snout towards the anal opening; the snout is angular (Pl. XXII.[a] fig. 3), truncated vertically posteriorly, quite flattened laterally. The few primary spines present near the abactinal system were large, curved, cylindrical; the smaller secondary ones somewhat club-shaped. There were fragments of the ovaries which seemed long, slender, branching filaments, like those of *Pourtalesia laguncula*.

This species is also remarkable for not having, as in other species of the genus, its apical system divided by the encroachment of the posterior lateral ambulacra into a bivium and trivium (Pl. XXII.[a] fig. 6).

The tuberculation of this species, and the shape of the test, must have been very similar to that of *Pourtalesia ceratopyga*.

Station 272. September 8, 1875. Lat. 3° 48′ S., long. 152° 56′ W.; 2600 fathoms; bottom temperature, 1·0° C.; radiolarian ooze.

**Spatagocystis*.

Spatagocystis A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 206.

Test ovoid, actinal region flattened, the anteriorly prominent actinal keel extending to form an anal snout, the abactinal region of the test regularly arched, the anterior and posterior extremities rounded, the actinal groove sunken. In the apical system, the genital plates connected, placed in the trivium, separated from the bivium by the intercalated interambulacral plates.

This genus has, like *Pourtalesia* proper, a deeply sunken actinal groove. Its outline recalls, however, when seen from above, the Holasteridæ, and forms the transition between the slightly keeled Holasteridæ, and types with more prominent keels extending into a short and small anal snout, which is so highly developed in *Pourtalesia* proper. The anal groove is sharp, and shows how readily among the Holasteridæ we can pass from a slightly sunken anal system, forming but an unimportant depression on the anal extremity of the test, as in *Toxaster* and some of the Dysasteridæ, to a somewhat more sunken system as in *Cardiaster*, until we pass on the one side to a well-defined anal groove, as we find it in *Metaporhinus*, and on the other side to a similarly clearly defined anal groove, forming a deep re-entering angle in the posterior extremity above the small anal snout, a mere beak as it were, formed by the prolongations of the actinal keel beyond the level of the outline of the test of the posterior extremity. The coronal plates are of a much more uniform size, both in the ambulacral and interambulacral zones, and assume somewhat the regular arrangement so characteristic of *Cystechinus*, in which the Galeritic type of coronal plates is still quite prominent.

In some of the Pourtalesiæ already, such as *Pourtalesia ceratopyga*, and to a certain

extent even in *Pourtalesia laguncula*, the posterior interambulacral zone on the abactinal surface between the apical and the anal system is composed of nearly hexagonal plates, increasing very gradually in size from the abactinal system to the anal system. This uniformity of the plates is, however, in *Pourtalesia* entirely limited to the odd posterior interambulacrum, while in *Spatagocystis* the plates of the other zones become more uniform in size. This structural feature is also connected with the decrease in size of the actinal groove, as seen from *Spatagocystis*, *Echinocrepis*, *Urechinus*, and *Cystechinus*. The plates of the actinal plastron between the actinostome and the anal snout are also far less elongate than in *Pourtalesia* proper, though these plates are evidently the first to become differentiated, and appear to be the first trace of a passage between the Galeritidæ and the Spatangidæ proper, as far as we can trace this from the fossil genera. It is interesting in the recent Pourtalesiæ to compare the actinal plastrons of such genera as *Pourtalesia*, *Echinocrepis*, *Spatagocystis*, and *Cystechinus*, in connection with that of the Dysasteridæ, Galeritidæ, Hemiasteridæ, and Spatangina proper. Subanal fasciole indistinct.

**Spatagocystis challengeri* (Pls. XXVI.; XXVI.[a]; XXXIX. fig. 37; Pl. XLI. fig. 40; Pl. XLII. figs. 10–12; Pl. XLV. figs. 37–43).

Spatagocystis Challengeri, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 206.

The outline of the test seen from above (Pl. XXVI. figs. 3, 9) is regularly ovoid, slightly indented anteriorly, in profile arched, falling towards the posterior extremity (Pl. XXVI. fig. 1), and quite abruptly truncated anteriorly. The actinal floor is flattened anteriorly, with a prominent keel extending from the actinostome to the extremity of the anal snout (Pl. XXVI. figs. 1, 2), the ambitus gracefully arched. The test is thin, quite brittle.

All the specimens collected as well as the fragments of tests were of a pinkish-violet tint. The genital organs consist of large yellowish clusters hanging far down from the abactinal region by long slender ducts, the different clusters of the genital organs quite distinct. The lateral interambulacra are very broad (Pl. XXVI.[a] fig. 9), the coronal plates are broad, and carry primary tubercles (Pl. XXVI.[a] figs. 2, 4, 12, 15, 16) uniformly scattered over them, carrying fine slender spines (Pl. XXVI. figs. 1–5). The whole test closely covered with miliary and secondary spines.

On the actinal surface the spines are somewhat larger (Pl. XXVI. fig. 2); the actinostome is small and deeply sunken (Pl. XXVI. fig. 2; Pl. XXVI.[a] fig. 2). The edges of the deeply-sunken actinal groove are quite well defined on the actinal side, the groove resembles the elliptical anal groove of *Echinobrissus*. Like the anal groove of some species of that genus it does not run indistinctly into a broad groove, and is limited to one side of the test.

In *Pourtalesia* proper the actinal groove passes very gradually into a broad anterior groove, which occupies the greater part of the anterior extremity of the test, while in

Spatagocystis the actinal groove is limited to the actinal surface (Pl. XXVI.[a] fig. 2), and the extension of the actinal groove from the actinal side over the ambitus to the abactinal side forms but a slight indentation in the anterior part of the test (Pl. XXVI. fig. 3).

There is a small anal snout (Pl. XXVI. fig. 1; Pl. XXVI.[a] figs. 11, 13, 15, 16), with a sharp beak extending below the anal system; there is no trace of a well-defined fasciole, but there are miliary tubercles closely packed at the tip of the snout on the lower side (Pl. XXVI.[a] fig. 12), these correspond undoubtedly to the distinct sub-anal fasciole encircling the anal snout of *Pourtalesia* proper. This fasciole, while very distinct in some species of *Pourtalesia*, is somewhat ill-defined in others, and thus readily passes into such an indistinct accumulation of miliaries as we find in *Spatagocystis*, where it forms the first trace of the sub-anal fasciole of the group. The anal pouch (Pl. XXVI.[a] fig. 6) is much shallower than in *Pourtalesia* proper.

The test seen facing the posterior extremity (Pl. XXVI. fig. 5) shows how prominent the keel formed by the prolongation of the actinal plastron has become. The test is regularly arched, and nearly as gibbous on the actinal side (with the exception of the somewhat flattened anterior extremity) as on the abactinal side.

Seen facing the anterior extremity the sunken actinal groove is seen to extend but little into the anterior part of the test above the ambitus (Pl. XXVI. fig. 4).

The extremity of the anal snout barely extends in the largest specimens collected (Pl. XXVI. fig. 1) as far out as the line of the abactinal hood over the anal system (Pl. XXVI.[a] figs. 15, 16). In young specimens which are more elongate (Pl. XXVI. figs. 8, 9) and more pointed posteriorly, the actinal keel is exceedingly prominent when seen in profile (Pl. XXVI. fig. 7), projecting beyond the line of the abactinal hood of the anal system. In these younger specimens the beak is also more limited to the posterior area, and the test is more flattened on the actinal side, and less gibbous as is well shown in the figures seen from the anal or actinal extremity (Pl. XXVI. figs. 10, 11).

This species is remarkable for the great length of the narrow plates composing the posterior lateral interambulacra (Pl. XXVI.[a] figs. 15, 16) and the anterior zone of the posterior lateral ambulacra; the width of the other areas forming the sides of the test is more uniform (Pl. XXVI.[a] fig. 9), the median odd interambulacral zone which forms the crest of the rounded part of the abactinal region of the test is very narrow (Pl. XXVI.[a] fig. 17), and is composed of plates of nearly uniform size extending to the abactinal region of the anal hood (Pl. XXVI.[a] figs. 10, 17). This is flanked by one row of rather smaller ambulacral plates forming the posterior zone of the lateral posterior ambulacra; in fig. 10 the outer plates should be perforated by the pores, and not the median rows of plates, which are the plates composing the odd interambulacral zone (Pl. XXVI.[a] fig. 17). The anterior zone of the lateral posterior ambulacra is composed of wider plates (Pl. XXVI.[a] fig. 15). The apical system corresponds to the apex placed anteriorly; there are three genital pores, the madreporic body is distinct; there are four genital plates

adjoining, placed within the trivium and separated from the bivium by the intercalated interambulacral plates (Pl. XXVI.[a] fig. 8).

The anal pouch (Pl. XXVI.[a] figs. 5, 6) is as in the Pourtalesiæ strengthened by large irregularly-shaped rectangular plates, and is somewhat triangular when seen from above (Pl. XXVI.[a] fig. 7); the opening is well covered by rather stouter spines than are found on other parts of the test. Figs. 2, 4, 7, 12 of Plate XXVI.[a] show the arrangement of the plates of the actinal surface of the test, and a combination of the figures 8, 9, 15, and 17, that of the abactinal side of the test.

The course of the alimentary canal is easily traced in the view of the interior (Pl. XXVI.[a] fig. 1) from the actinal side, and in the profile of Pl. XXVI. fig. 6. The course and the shape of the alimentary canal is similar to that of *Cystechinus.* The anal extremity of the canal is remarkable for its small size (Pl. XXVI.[a] fig. 6).

The largest and the smallest specimens collected are figured natural size on Plate XXVI. The collection also included a couple of intermediate sizes.

Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E.; 1600 fathoms; bottom temperature, 0·8° C.; globigerina ooze.

Station 157. March 3, 1874. Lat. 53° 55′ S., long. 108° 35′ E.; 1950 fathoms; diatom ooze.

**Echinocrepis.*

Echinocrepis, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 206.

This genus has, like *Pourtalesia*, a sunken actinal groove, but the other features of the test differ entirely from those of the species thus far described in this family. There is no anal snout, the anal system though forming a re-entering pouch much as in *Pourtalesia* is situated on the actinal side as in *Cystechinus.* Seen in profile the test is pyramidal (Pl. XXVII. fig. 3), the apical system is placed about one-third the length of the test from the anterior end; the anterior part of the test forms a regularly inclined surface sloping rapidly from the apex to the ambitus with sharply rounded corners; towards the actinal surface and at the median line of the lateral anterior ambulacrum on the upper part of the test, the actinal groove forms a comparatively slight depression on the actinal surface of the anterior edge of the test, but owing to the gradually sloping sides of the edge of the actinal groove, extending from the flat actinal anterior part of the test (Pl. XXVII. figs. 5, 7), and taken in connection with the flat sloping test of the anterior extremity and its deep re-entering angle when seen from above, it forms, when seen from the anterior extremity, a groove deeply cut out of the test. As seen from above the anal keel forms a slight arch from the apex to the anal extremity. The median line of the anterior lateral ambulacra is slightly re-entering, forming a deep indentation in the anterior outline of the test as seen from above.

The very slight re-entering angle of the median line of the posterior lateral ambu-

lacra does not extend beyond the ambitus. These deflections give the test an angular outline when seen from above (Pl. XXVII. figs. 1, 2; Pl. XXXV.[a] figs. 9, 10), the median interambulacral spaces bulging beyond the general outline. The sides of the test slope similarly to the anterior extremity from the apex to the ambitus; the median ridge connecting the posterior planes is quite rounded and passes into an arched surface above the anal system, while the junction of the lateral planes of the test, and the flattened anterior extremity form quite well-marked slightly-rounded angles corresponding to the outer edges of the anterior extremity of the test (Pl. XXVII. figs. 1, 3; Pl. XXXV.[a] figs. 9, 11). The general trend of the outline of the test as seen from above tapers very gradually towards the anal extremity from the anterior edge of the test (Pl. XXVII. figs. 1, 2; Pl. XXXV. figs. 9, 10) to the line of the lateral posterior interambulacra; here it bulges out somewhat, and from the median line it slopes more rapidly to the anal end, which terminates in a rounded point.

The plates composing the test of this genus are, as in *Spatagocystis*, far less elongate than in *Pourtalesia* proper. The plates of the actinal surface, especially those of the lateral ambulacral and interambulacral zones (Pl. XXXV.[a] fig. 10), being elongate, while on the abactinal surface above the ambitus the coronal plates are comparatively quite uniform in size (Pl. XXXV.[a] figs. 9, 11, 12) and more or less hexagonal. The arrangement of the plates of the abactinal side of the test in *Spatagocystis* is very similar to that of *Echinocrepis*, but in the former genus there is a more marked difference between the size of the plates of the anterior and posterior halves of the ambulacral and interambulacral zone than we find in the latter genus. The elongated plates forming the actinal surface of these genera do not seem to be due to the more elongate shape of the test, for in genera with a more circular outline the plates may be fully as elongate as in *Echinocrepis* and *Spatagocystis.* This elongation of the actinal plates seems mainly due to the greater or less eccentricity of the actinostome, and is not always an indication of the more Spatangoid affinity of the genera, where we find the test on the abactinal surface as in *Spatagocystis* and especially in *Cystechinus* composed of coronal plates, showing but slight differences in size in adjoining ambulacral and interambulacral areas, which are thus made up of very nearly the same number of plates, somewhat as we find it among some of the genera of Ananchytidæ.

The anal snout has completely disappeared, the only remnant of it is the very slight rounded actinal keel extending from the actinal edge of the anal system a short distance towards the actinostome. The rounded arched and somewhat projecting posterior extremity of *Spatagocystis*, forming a sort of hood over the anal system, is barely represented by the slightly projecting extremity of the median interambulacral area of the test immediately above the anal system. With the disappearance of the anal snout the subanal fasciole has also vanished, and the miliaries, the last of this fasciole, are merely somewhat crowded on the actinal edge of the anal system, and on the edge of the plates of the test forming the outline of the anal system.

**Echinocrepis cuneata* (Pls. XXVII., XXXV.[a] figs. 8–13; Pl. XXXIX. figs. 31, 32; Pl. XLI. figs. 30, 31; Pl. XLIII. fig. 14; Pl. XLV. figs. 44, 45).

Echinocrepis cuneata, A. Agassiz, 1879, Proc. Am. Acad, vol. xiv. p. 206.

Seen from the anterior extremity (Pl. XXVII. fig. 5) the outline is that of a truncated cone, with rounded corners and a deep re-entering angle formed by the width of the actinal groove. Seen from the posterior extremity the broad rounded anal keel projecting over the anal system (Pl. XXVII. fig. 4) extends below the general level of the actinal surface, and when seen in profile (Pl. XXVII. fig. 3; Pl. XXXV.[a] fig. 11) forms an indistinct hood over the anal system.

The apical system of this species is compact (Pl. XXVII. fig. 9), placed in the trivium and separated by the accessory interambulacral plates from the bivium, the genital plates are indistinct, the madreporic body is very prominent; the interambulacral plates are rendered prominent by the presence of a single large primary tubercle on each plate replacing the regular uniform granulation of smaller primaries covering the greater part of the rest of the test as in Plate XXVII. fig. 8. The test is covered on the abactinal side with primary tubercles, quite uniformly but irregularly distributed over the plates of the ambulacral and interambulacral systems (Pl. XXXV.[a] figs. 9–12). These carry small, slender, fine spines of a moderate length. The space between the primaries is filled with minute secondary spines (Pl. XXVII. fig. 8). Minute triangular pedicellariæ are found specially numerous in the depressed median ambulacral spaces. Near the abactinal system a number of larger primary tubercles are placed on the upper plates of the interambulacral areas (Pl. XXVII. figs. 1, 3, 5, 9; Pl. XXXV.[a] figs. 9, 11); these carry somewhat larger and longer spines than those on the rest of the test. The actinal side is generally flat with a slight rounded ridge, formed by the actinal keel, extending from the anal system to the actinostome and the indistinct ridges formed in the median line of the anterior interambulacral areas; there these ridges form lines from which the test slopes to the depressed median line of the anterior lateral ambulacra. The primary tubercles of the actinal keel are large and closely crowded, extending round the anal extremity (Pl. XXVII. fig. 10; Pl. XXXV.[a] fig. 10). The other primary tubercles of the actinal side are also larger and more distant than on the abactinal side (Pl. XXVII. fig. 1; Pl. XXXV.[a] fig. 10); they are again somewhat smaller, and more closely packed on the anterior part of the test towards the ambitus, on the actinal side, and in the anterior interambulacral areas. The general ground tint of the test is violet-brown, the spines are brownish-yellow, but when denuded the test is light violet.

The spines immediately in the actinal groove are longer and larger than any others on the test and slightly club-shaped. The anal system is elliptical, placed on the actinal side of the test on a slightly inclined plane, forming the junction of the actinal and abactinal surfaces at the posterior extremity of the test (Pl. XXVII. figs. 3, 4, 10; Pl. XXXV.[a] figs. 10, 11). The anal pouch is quite flat and

shallow. The test of this species is comparatively stouter than in the other genera of the family.

There were, unfortunately, only two specimens collected by the Challenger; they are figured natural size on Plates XXVII. and XXXV.[a]

Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E.; 1600 fathoms; bottom temperature, 0·8° C.; globigerina ooze.

* *Urechinus.*

Urechinus, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 207.

At first sight this genus appears closely allied to *Neolampas*, of which it has the general outline. The posterior region of the test forms as in that genus the hood protecting the anal system. The difference in the proportion of the plates composing the ambulacral and interambulacral areas as well as the structure of the actinostome at once distinguish it from *Neolampas*. It has, like the Pourtalesiæ, large high plates forming the ambulacral zones differing little in height from the adjoining ambulacral plates. It has a nearly circular actinostome like that of *Cystechinus* slightly sunken below the level of the actinal surface. The abactinal system is disconnected; two of the genital plates go with the trivium, the others with the bivium.

* *Urechinus naresianus* (Pl. XXIX. figs. 1–4; Pls. XXX., XXX.[a] figs. 1–14; Pl. XXXIX. figs. 29, 30; Pl. XL. figs. 56–58).

Urechinus naresianus, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 207.

The largest specimens collected measured 48 mm.; the test was of a reddish-brown colour forming the ground-work upon which stood out in prominent contrast the delicate slender primary spines with broad bases (Pl. XXX. fig. 20), of a yellowish-white, as well as the numerous minute secondary and miliary spines thickly crowding the whole test. In these large specimens the primary tubercles remain comparatively large; they are never numerous, each primary coronal plate carrying but few; they are more numerous on the actinal side. In the younger stages, even when the specimens have attained 25 mm. in length, each coronal plate was occupied by but a single primary tubercle both in the ambulacral and interambulacral areas (Pl. XXX. figs. 1–3), the rest of the plate being thickly covered by miliaries and secondaries. The youngest specimens collected have already the same general arrangement, and differ but little from the older specimens (Pl. XXX. figs. 4–13); these are somewhat more elongated and more flattened; the anterior extremity of the test when seen in profile (Pl. XXX. figs. 9, 13) being comparatively more gibbous.

In all the stages examined the actinal surface was more closely tuberculated than the abactinal region, the miliary and secondary spines forming a close down over the whole of that surface. Seen from above the test is elliptical, slightly tapering at the posterior extremity (Pl. XXIX. fig. 1; Pl. XXX. figs. 1, 4, 7, 8, 11). Seen

in profile, the test slopes regularly from the anterior to the posterior extremity in the adult (Pl. XXX. fig. 2), this posterior extremity is sharply arched over the anal hood then vertically truncated, sloping anteriorly with a rounded corner joining the indistinct actinal keel (Pl. XXIX. figs. 2–4). In younger specimens the anal system is more at the extremity of the narrow end of the test (Pl. XXX. figs. 5, 9, 13), and the actinostome is also somewhat more central (Pl. XXX. figs. 3, 10) than in the older specimens (Pl. XXIX. fig. 3). In the youngest specimens, measuring 14 mm., there is already an indistinct subanal fasciole (Pl. XXX. fig. 19); this fasciole is never very distinct, the miliaries of the band being always more or less disconnected as in the specimen figured on Plate XXX. fig. 19, which measured 24 mm. in length. The anal system consists of numerous small irregularly-shaped plates (Pl. XXX. fig. 18). The indistinct actinal keel of *Urechinus* is scarcely more prominent than in such genera as *Rhynchopygus* and *Cassidulus*. Large trifid long-stemmed pedicellariæ (Pl. XXX. fig. 22) are found in the actinal region near the actinostome; the shorter round-headed pedicellariæ (Pl. XXX. fig. 23) occur on the abactinal surface of the test above the ambitus.

A large number of specimens of this species were collected, showing a great degree of variation in the tuberculation of the abactinal surface of the test (compare Pls. XXX. and XXX.[a]), in the outline of the test not only when seen from above (Pl. XXX. figs. 1, 7), but especially when seen in profile and from the anterior and posterior extremities (compare Pl. XXX. figs. 2, 5, 6, 9, 13, with Pl. XXX.[a] figs. 3, 4, 5, 7, 12–14).

In the specimen figured on Plate XXX.[a] figs. 7–9, we find that it agrees very closely with the young of Plate XXX. figs. 1–3. In another specimen (Pl. XXX.[a] figs. 10–14) the outline in profile is quite different (Pl. XXX.[a] fig. 12), the test is highest posteriorly, and we find a slight tendency to the development of an anal snout. The anal system is more elliptical (Pl. XXX.[a] fig. 10*a*), and the subanal fasciole is quite markedly developed, and the primary tubercles are somewhat more numerous. This specimen also had only three genital pores, while in specimens of the size of fig. 8, Plate XXX.[a] there are usually four. The madreporic body is quite indistinct both in figs. 8 and 11 (see fig. 8*a*). There is in these two specimens (Pl. XXX.[a] figs. 9, 10) quite a marked accumulation of miliaries on the edge of the actinal interambulacral plate, rudimentary bourrelets as it were.

I have also figured on Plate XXX.[a] figs. 1–6, an elongate conical specimen of *Urechinus*, which I refer with some doubt to this species. At first sight it appears totally distinct, but with the exception of the apex of the test there are no structural differences to be noticed in this specimen. The test is comparatively thinner; the striking feature is the great development of the anterior lateral interambulacra near the apical part of the test, forcing the ambulacra towards the posterior extremity (Pl. XXX.[a] figs. 1, 3). It is difficult to make out satisfactorily the plates composing the sharp crest which forms the apex of this specimen (Pl. XXX.[a] figs. 1, 3, 4, 5). We could imagine

this specimen to be an exaggeration of some of the younger stages (Pl. XXX. figs. 6, 7), which show a very marked tendency towards a high conical test. The specimen figured on Plate XXX.[a] figs. 1–5 has, like the younger stages, only one large well-developed primary tubercle on each coronal plate of the abactinal part of the test. This abnormal specimen of *Urechinus naresianus* shows how close is the affinity between *Urechinus* and *Cystechinus*, and that we may have in these genera fully as great a difference in the outline of the test as we find in any of the species of *Ananchytes* from the Chalk.

The colour of the test in alcohol varies from a dirty yellow to a dark brownish-red.

Station 146. December 29, 1873. Lat. 46° 46′ S., long. 45° 31′ E.; 1375 fathoms; bottom temperature, 1·5° C.; globigerina ooze.

Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E.; 1600 fathoms; bottom temperature, 0·8° C.; globigerina ooze.

Station 158. March 7, 1874. Lat. 50° 1′ S., long. 123° 4′ E.; 1800 fathoms; bottom temperature, 0·3° C.; globigerina ooze.

Station 302. December 28, 1875. Lat. 42° 43′ S., long. 82° 11′ W.; 1450 fathoms; bottom temperature, 1·5° C.; globigerina ooze.

**Cystechinus.*

Cystechinus, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 207.

This genus has the facies of *Ananchytes*, and is also closely allied to *Galerites*. It has, like the latter, the test made up of plates of nearly uniform size in the different interambulacral areas, and large plates like the Ananchytidæ in the ambulacral areas, and a slightly sunken actinostome. In this genus the actinostome is less eccentric than is usual in Spatangoids, and in this respect one of the Galeritic features of the genus is strongly marked. The anal system is just below the ambitus, but it has the abactinal system of the Ananchytidæ. It, however, forms a most interesting genus, and with *Pourtalesia*, which was first described from the dredgings of Mr Pourtalès and the allied genera *Palæotropus*, *Neolampas*, and the like, shows the affinities of the Spatangoids with the Echinolampadæ.

It has, like all Pourtalesiæ, simple ambulacral pores. It is remarkable how the structure of so many of the Spatangoid forms is satisfactorily explained by the different genera of Pourtalesiæ collected by the Challenger, and how greatly the knowledge of the members of this family has helped us to understand the true relationship, not only of many aberrant groups of Spatangoids, but also their relationship to the Clypeastroids and Echinolampadæ.

In addition to the proportions of the coronal plates in the ambulacral and interambulacral areas, the rudimentary auricles, the raised edge of the actinal opening described in the following species are points specially interesting.

**Cystechinus clypeatus* (Pl. XXXV.[b] figs. 10, 11; Pl. XLII. figs. 15, 16; Pl. XLV. figs. 29–31).

Cystechinus clypeatus, A. Agassiz, 1879, Proc. Am Acad., vol. xiv. p. 208.

Numerous fragments of a large species of *Cystechinus* were collected, some of which were fragments of the abactinal surface with the anal system well preserved. This showed a different arrangement of plates from those of either *Cystechinus vesica* or *Cystechinus wyvillii,* both in the apical system and in those of the coronal plates of the abactinal region. The terminal coronal plates are larger and form rows, the interambulacra and ambulacra consisted evidently of fewer plates than in the other species of the genus. The abactinal system resembles closely that of *Cystechinus wyvillii;* the genital plates are, however, proportionally larger, the left anterior and the right posterior far exceeding the others in size, and extending entirely across the abactinal area, the whole central part of which is formed by the junction of the genital plates.

The madreporic body is more concentrated than in any other species of this genus, forming a sharp, well-defined triangular button on the right anterior genital plate. There are four genitals all equally developed, and, in the fragments preserved, all greatly expanded, forming huge clusters round the apical system. A piece of the actinal surface near the actinostome shows that in this species the actinal surface is more closely covered with primary tubercles than the other parts of the test. The spines are whitish, long, slender, cylindrical, somewhat curved, the shaft slightly swollen towards the anterior extremity beyond the middle. The miliaries are quite numerous, carrying short, straight, sharp cylindrical spines. Near the actinostome the primary spines are short and club-shaped, and the whole space between the primaries is thickly covered with secondary spines and short-stemmed pedicellariæ, which are large-headed, pyramidal, and rounded.

The actinal membrane and the immediately adjoining parts of the test are thickly covered with short miliary club-shaped spines. The large elliptical anal system is placed with its longest diameter vertically, and is protected by numerous irregularly-shaped plates (Pl. XXXV.[b] fig. 11) carrying miliaries; the anal opening is small and placed centrally. The edge of the test adjoining the anal system is thickly covered by miliaries forming a broad band, with an indistinct outer edge (almost a fasciole) surrounding it; this band of miliaries gradually passes into the miliary tuberculation of the adjoining part of the test.

The test of this species is quite stout, judging from the thickness of the fragments preserved, and measuring similar parts of *Cystechinus wyvillii;* this species must have attained at least 200 mm. in diameter. In the specimens from the greatest depths at which this species has been found, the test is much thinner than in the fragments which are found near the 1000 fathom line.

As a general rule among the Pourtalesiæ, the test of the different species having an extended bathymetrical range varies very materially in thickness, according to the depth

at which the specimens were dredged. Specimens of the same species from shallower regions, having pretty generally a comparatively stouter test. I may refer to the evidence furnished from the different species of *Pourtalesia*, *Cystechinus*, and *Urechinus*.

Station 133. October 11, 1873. Lat. 35° 41′ S., long. 20° 55′ W.; 1900 fathoms; bottom temperature, 1·3° C.; globigerina ooze.

Station 205. November 13, 1874. Lat. 16° 42′ N., long. 119° 22′ E.; 1050 fathoms; bottom temperature, 2·4° C.; grey ooze.

Station 334. March 14, 1876. Lat. 35° 45′ S., long. 18° 31′ W.; 1915 fathoms; bottom temperature, 1·5° C.; globigerina ooze.

**Cystechinus vesica* (Pls. XXXV., XXXV.ª figs. 5–8; Pl. XXXIX. fig. 27; Pl. XLI. figs. 36, 37; Pl. XLIII. figs. 9–12; Pl. XLV. figs. 32–35).

Cystechinus vesica, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 209.

This species is distinguished by the large size of the ambulacral plates of the abactinal side, the uniform structure of the ambulacra on the actinal side, and the regular arrangement of the coronal plates on the abactinal side of the test.

The anal system is made up of numerous irregularly-shaped plates (Pl. XXXV. figs. 9, 10). The ampullæ (Pl. XXXV. fig. 13) of the tufted actinal tentacles (Pl. XXXV. fig. 20) round the actinostome are elongate. The majority of the primary spines are solid, straight, longitudinally striated (Pl. XXXV. fig. 14), with a broad base or else smooth and cylindrical. A few large club-shaped primary spines (Pl. XXXV. fig. 15) coarsely striated at the extremity and slightly curved were also left. The smaller miliary spines are also club-shaped, slightly curved, and with serrated edges at the extremity. The apical system is disconnected, supernumerary interambulacral plates separating the bivium from the trivium (Pl. XXXV.ª fig. 5); there are three genitals (Pl. XXXV. figs. 6, 7), forming small grape-like clusters attached closely to the apical system; the madreporic body is large. Pedicellariæ of three kinds, one of which is similar to the Clypeastroid pedicellariæ of *Pourtalesia* figured in the Revision of the Echini, the second kind are large, trifid, triangular and short-stemmed (Pl. XXXV. fig. 16), the third kind are short-stemmed and club-shaped (Pl. XXXV. figs. 17, 18).

The actinal system is covered by a small number of large triangular plates, extending from the actinal edge of the test to the actinostome (Pl. XXXV. fig. 12); on the abactinal surface of the test the tubercles are not as closely placed as upon the actinal side; we find only a small number of primary spines irregularly scattered over the test (Pl. XXXV. figs. 1, 2); the miliaries and secondaries are few in number and irregularly scattered over the coronal plates. Actinostome not labiate, circular (Pl. XXXV. figs. 8, 11, 12), with a slightly, raised edge internally corresponding to the auricles in the regular Echinids and Clypeastroids. In this species the relationship of this genus with the Desmosticha and Clypeastroids is quite striking. The large ambulacral plates, the barely disconnected

ambulacral system at the abactinal pole, the flat actinostome with its internal rudiments of supports for teeth still existing, are all features which we do not associate with the group of Spatangoids. I have already called attention to the general similarity of this genus with *Galerites;* in the latter we still find teeth, smaller ambulacral plates, the same actinostome, however, only more Clypeastroid; and the arrangement of the tubercles (primary, secondary, and miliary) is very similar in *Galerites* to that of the tubercles of the present group.

The outline of the test of this species when seen from the apical pole on the actinal surface is elliptical, the anterior and posterior extremities equally rounded (Pl. XXXV. figs. 1, 3). The actinostome is placed somewhat in advance of the centre, the apical system and apex are coincident, slightly posterior. The actinal surface is flat, slightly sunken from near the ambitus; the ambitus forms a sharp curve between the actinal surface and the sides of the test (Pl. XXXV. fig. 2); owing to the extreme tenuity of the test, it is difficult to see its outline when seen in profile, the mere weight of the test forming large folds extending from the apex to the ambitus (Pl. XXXV. figs. 1, 2, 4). The outline when fully expanded, probably resembled that of *Cystechinus wyvillii,* only at the ambitus the test is less gibbous, the posterior extremity more rounded and sloping more vertically, and the anterior extremity sloping quite uniformly with but a slight re-entering angle from the rounded apex to the ambitus.

It is difficult in the ill-shaped test, looking like an old felt hat, figured on Plate XXXV. fig. 4, to recognise the outline of a graceful test such as this species undoubtedly had, judging from that of the allied *Cystechinus wyvillii.*

The anal system in this species is placed well above the actinal surface flush with the test (Pl. XXXV. fig. 2), and there is no trace of a hood or rudimentary abactinal beak as in *Cystechinus wyvillii.*

This is the only Spatangoid thus far known, which can evidently expand or contract its test. This was known in the Diadematidæ (*Astropyga*) among the regular Echinids, previous to the discovery of the Echinothuridæ among the recent forms; in these the test is, as I have said, capable of very great expansion and contraction and extensive change of shape. The lapping of the coronal plates of some Spatangoids, to which Ludwig[1] has called attention, is undoubtedly an apparatus adapted within narrower limits for the same purpose.

Station 153. February 14, 1874. Lat. 65° 42′ S., long. 79° 49′ E.; 1675 fathoms; mud.

Station 298. November 17, 1875. Lat. 34° 7′ S., long. 73° 56′ W.; 2225 fathoms; bottom temperature, 1·3° C.; grey mud.

Station 299. December 14, 1875. Lat. 33° 31′ S., long. 74° 43′ W.; 2160 fathoms; bottom temperature, 1·1° C.; grey mud.

[1] H. Ludwig, Morphologie der Echinodermen, 1877–79, vol. iii. pp. 131–140.

**Cystechinus wyvillii* (Pl. XXIX. figs. 5–8; Pls. XXIX.[a], XXIX.[b]; Pl. XXXIX. fig. 28; Pl. XL. figs. 59, 60; Pl. XLI. figs. 23–27; Pl. XLII. figs. 13, 14; Pl. XLV. figs. 25–28).

Cystechinus Wyvillii, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 208.

In a large specimen figured on Plate XXIX.[b] the outline of the test seen from above is elliptical, broadly rounded anteriorly, and having the posterior extremity somewhat more pointed than the anterior (Pl. XXIX.[b] fig. 1). Seen from the actinal side the actinostome is transversely elliptical, eccentric, placed anteriorly; the actinal surface is quite flat. An indistinct, low, broad, actinal keel is formed by a slight swelling of the posterior interambulacral space between the actinostome and the anal system. The anal system is placed near the ambitus in a slightly bevelled plane, passing to the broad, indistinct, rounded, abactinal anal hood (Pl. XXIX.[b] fig. 3). The apical system is slightly eccentric posteriorly, so that when seen in profile the anterior extremity slopes out more gradually from the rounded apex, which is coincident with the apical system, than the more suddenly sloping posterior extremity.

The abactinal part of test, sloping uniformly for a short distance from the apex (Pl. XXIX.[b] figs. 3, 4), forms a slight re-entering curve before it passes into the gibbous ambitus, which, when seen in profile, is specially prominent in the anterior extremity of the test owing to the eccentric position of the apex. Seen facing the odd posterior interambulacrum the test has an uniformly arched and re-entering curve (Pl. XXIX.[b] fig. 4). This species has a comparatively stout test, and, to judge from the fragments of some incomplete specimens from Station 296, it must have attained a diameter of at least 130 mm., and a proportional height. The coronal plates are of very uniform size (Pl. XXIX.[b] figs. 1–4), gradually becoming smaller towards the apex on the abactinal surface, and towards the actinostome on the actinal surface, there is but little difference in the size of the plates of the ambulacral system, and those of the interambulacral areas, as in this genus the former are comparatively large. The odd posterior interambulacral area is somewhat narrower than the other; the lateral interambulacral areas are slightly the broadest. Seen from the actinal side, the plates towards the ambitus (Pl. XXIX.[b] fig. 2) become very much elongated, but become again quite hexagonal on the actinal floor towards the actinostome. The whole test is covered with very small, sharp, cylindrical, spines (Pl. XXIX. figs. 5–8), these and the miliaries are sufficiently thick to hide completely the sutures of the plates, and the lines separating the ambulacral and the interambulacral zones (Pl. XXIX. figs. 5–8). Minute pointed pedicellariæ are scattered irregularly over the whole test.

Each coronal plate (Pl. XXIX.[b] figs. 1–4, 9) carries but few primary tubercles, supporting thin short delicate cylindrical spines, the intertubercular space being covered with irregularly scattered miliaries (Pl. XXIX.[b] fig. 9). Each coronal plate is also ornamented by ridges radiating from the angles of the plate (Pl. XXIX.[b] fig. 9) towards the central

summit, which is somewhat raised; these radiating ridges give to the abactinal part of the test (Pl. XXIX.[b] fig. 3) quite a variegated appearance, as they are somewhat darker in colour than the groundwork of the plate itself. The outline of the test is extremely variable, fully as variable as that of some of the species of *Galerites* and *Ananchytes*. The actinal interambulacral plate adjoining the actinostome is slightly turned up in the interior of the test, and forms a thin ridge similar to the ridge connecting the auricles in genera provided with teeth. The ovaries (Pl. XXIX.[a] fig. 13) are thick close clusters of short grape-like processes; there are four genital plates, all of which carry genital organs equally developed. The large size of the ampullæ of the ambulacral tentacles is remarkable, they are developed into large vesicles round the actinal region (Pl. XXIX.[b] fig. 6).

The membrane of the actinostome of the younger specimens is strengthened by a smaller number of larger plates, forming a single row, in the centre of which, on the posterior edge of the actinal opening, are placed seven to eight smaller plates irregularly arranged (Pl. XXIX.[a] fig. 18).

This arrangement differs materially from that figured on Plate XXIX.[b] fig. 5, of a large specimen, in which the secondary plates of the actinal membrane have become nearly as large as the primary row. In the actinostome of the larger specimens there is the least possible indication of a rudimentary bourrelet in the crowding of the three or four primary tubercles, on the actinal edge of the narrow interambulacral plate adjoining the actinostome (Pl. XXIX.[b] fig. 5). There is no trace of this in the younger specimens (Pl. XXIX.[a] figs. 16, 18); although the primary tubercles are large, yet they are not closely crowded together as in older specimens. The actinal opening is generally transversely elliptical (Pl. XXIX.[b] figs. 2, 5), but this is by no means constant, as it is in some cases nearly circular (Pl. XXIX.[a] fig. 18). The apical system (Pl. XXIX.[a] fig. 14) is disconnected, two of the genital plates belonging to the trivium, and two to the bivium, separated by large intercalated interambulacral plates, upon one of which the madreporic body often encroaches, and is in some cases placed entirely upon one of the intercalated interambulacral plates. The anal system is vertically elongated, strengthened by an outer row of large plates (Pl. XXIX.[a] fig. 20) with a number of smaller plates immediately round the anal opening. An interior view shows that the termination of the alimentary canal is sudden, forming a short intestine (Pl. XXIX.[a] fig. 19).

In young specimens (Pl. XXIX.[a] figs. 1–12) the test is flattened, the outline seen in profile is regularly arched, rounded anteriorly and posteriorly, and passing very gradually to a flattened actinal surface. Seen facing the posterior extremity the test is similarly regularly arched (Pl. XXIX.[a] fig. 11), the apical system and apex coincident and central, the posterior extremity when seen from above, but slightly smaller than the anterior (Pl. XXIX.[a] figs. 1, 5, 9). The anal opening, however, is already placed on the actinal surface in the youngest of the specimens collected.

The outline is somewhat more elliptical (Pl. XXIX.[a] figs. 1, 5, 9), and the actinostome more excentric than in older specimens; the proportions of the coronal plates do not differ materially in these younger specimens from those in the larger specimens, the greatest disproportion being of course in the comparative size of the primary tubercles, especially on the actinal surface. In the abactinal system in the largest of the young specimens figured, the only difference in the arrangement of the apical plates is, that the madreporic body has not yet encroached upon the plate separating it from the posterior lateral genital plate (Pl. XXIX.[a] fig. 12′), and that the accessory plates separating the genital plates from the anterior ambulacral areas are proportionally not as large as in the largest specimen (Pl. XXIX.[a] fig. 14), so that the ocular plates are comparatively nearer together. In a still younger specimen, measuring only 22 mm., the apical system showed the small intercalated plates between the anterior genital, and the termination of the odd ambulacrum (Pl. XXIX.[a] fig. 11′). Although the apical system is thus generally identical, there is great variation in specimens of different sizes, in the relative size of the genital plates, and the development of the intercalated plates.

In all these younger, more elliptical stages, the ambulacral areas are somewhat broader in proportion to their height (Pl. XXIX.[a] figs. 1–12); than in such a large fully developed specimen as that figured on Plate XXIX.[b] figs. 1–4.

On the actinal side in these young specimens, we find the plates of the ambulacral and interambulacral areas more uniform in size; they do not become elongated towards the ambitus as do those of older specimens (Pl. XXIX.[a] figs. 3, 6, 10).

Station 146. December 29, 1873. Lat. 46° 46′ S., long. 45° 31′ E.; 1375 fathoms; bottom temperature, 1·5° C.; globigerina ooze.

Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27 E.; 1600 fathoms; bottom temperature, 0·8° C.; globigerina ooze.

Station 158. March 7, 1874. Lat 50° 1′ S., long. 123° 4′ E.; 1800 fathoms; bottom temperature, 0·3° C.; globigerina ooze. South Australia.

Station 296. November 9, 1875. Lat. 38° 6′ S., long. 88° 2′ W.; 1825 fathoms; bottom temperature, 1·2° C.; red clay.

Station 299. December 14, 1875. Lat. 33° 31′ S., long. 74° 43′ W.; 2160 fathoms; bottom temperature; 1·1° C.; grey mud.

Station 300. December 17, 1875. Lat. 33° 42′ S., long. 78° 18′ W.; 1375 fathoms; bottom temperature, 1·5° C.; globigerina ooze.

**Calymne.*

Calymne, Wy. Thomson, 1877 Voyage of the Challenger, Atlantic, vol. i. p. 397.

Among the Echinids described by Thomson in his Voyage of the Challenger, vol. i. p. 397, figs. 102, 103, the present genus holds, like *Cystechinus*, an intermediate position

between the Pourtalesiæ proper and such genera as *Paleopneustes* and *Palæotropus*, in which the actinostome is more or less labiate, and in which the structure of the actinal surface resembles more closely that of the normal Spatangoids. *Calymne* has, like the Pourtalesiæ, simple ambulacral pores, a disconnected apical system retaining something also of its cylindrical shape; two of the ovaries in the trivium, the others not developed, the bivium well separated from it by intercalated interambulacral plates. It has a simple actinostome, and large ambulacral plates; the proportion between the size of the ambulacral and interambulacral plates is similar to that in *Cystechinus*. It has, unlike the Pourtalesiæ proper, an elliptical outline and a fasciole across the anterior edge of the test. The median interambulacral area of the actinal side forms a narrow rounded keel extending from the edge of the actinostome to the ambitus, but like *Cystechinus* a nearly flat actinal surface with a low rounded keel extending almost from the actinostome to the posterior edge of the test, where it runs into a small but well-defined subanal beak, the only remnant in this genus of the anal snout of the Pourtalesiæ proper. The presence of so well-defined a lateral fasciole in this genus is interesting, as otherwise the genus is eminently an old type, but combining with its ancient characteristics such as the uniform size of the coronal plates of the test on the abactinal surface, a disconnected apical system, a simple actinostome with the remarkably simple arrangement of the plates immediately surrounding it and a short elliptical outline, the more modern features of a distinct subanal beak, a lateral fasciole, an anal system high upon the posterior extremity of the test close to the abactinal surface, and an elongated actinal plastron with a well-defined lateral fasciole.

When seen in profile this genus retains of the Pourtalesiæ the cylindrical shape and the actinal surface slightly convex from the presence of a keel; and by the position and structure of its anal system it unites the Spatangina and the Pourtalesiæ by showing the connection of *Calymne* to *Urechinus*, *Cystechinus*, *Echinocrepis*, and *Pourtalesia* proper, in addition to such features as the presence of a lateral fasciole to which I have already alluded. The general outlines of the test recall on the one side the Ananchytidæ and on the other the Dysasteridæ, and even some of the Clypeastroids, and resemble to a very striking degree those of the test of young specimens of *Cystechinus*.

**Calymne relicta* (Pls. XXXIV., XXXIX. figs. 24–26; Pl. XL. figs. 63–65; Pl. XLIII. fig. 24; Pl. XLIV. figs. 47, 48).

Calymne relicta, Wy. Thomson, 1877, Voy. Chall., Atlantic, vol. i. p. 397, figs. 102, 103.

Only fragments of this species were preserved, from which, in connection with the drawings given by Thomson in the Challenger narrative, the figures on Plate XXXIV. have been reconstructed. I copy Thomson's description of this species (Voyage of the Challenger, Atlantic, vol. i. p. 397). "The test is 30 mm. in length and 20 mm. in height, and very elegant and symmetrical in form; the outline is oval, slightly truncated posteriorly,

a longitudinal ridge from which the sides of the shell slope off with a pleasing curve runs along the apical surface. The oral surface is nearly flat, and a slight keel runs round its edge, defining and limiting it very much as in *Ananchytes*, a fasciole follows the keel, only leaving it and appearing for a little part of its course on the oral surface in advance of the mouth. The mouth is oval, its long axis in the direction of the antero-posterior axis of the test. The excretory opening is on the posterior surface above the line of the peripheral ridge. The apical area is, if not disjunct, greatly produced, but it is difficult to make out the exact relations of some of the terminal plates of the ambulacral and interambulacral series. The ambulacra of the trivium meet at an anterior pole on the dorsal surface nearly opposite the mouth, and the two ovarial plates closing the two anterior interambulacral series bear large ovarial openings from which, as in *Aërope*, tubes of considerable length protrude; what appears to be a separate plate, immediately behind these bears the madreporic tubercle, only two ovaries are developed, and two plates only are perforated for their ducts. The two posterior ambulacra end at a secondary pole at a distance of about one-third of the length of the shell from the primary pole near its posterior extremity. The structure of the ambulacra is extremely simple, the ambulacral canal sending a simple diverticulum to a single minute pore near the centre of each ambulacral plate. The mouth is unarmed. The surface of the test bears somewhat sparsely scattered hair-like spines, and over the central portion of the oral surface, and on the apical surface near the posterior pole, are groups of delicately striated paddle-shaped spines. The general colour of the test and spines is pale green. Either the same species, or one very nearly allied to it was obtained in considerable numbers near Tristan da Cunha, but with a test not less than 200 mm. in length. The shell was, however, so extremely tender and thin that even with the trawl not a single example was got tolerably complete."

The actinostome is pentagonal (Pl. XXXIV. figs. 7, 8), and is strengthened by irregularly concentric rows of plates, the larger on the exterior edge.

Seen in profile (Pl. XXXIV. fig. 3), the course of the lateral fasciole on the edge of the slight keel, which marks the ambitus as it were, the line between the actinal and abactinal surfaces is well shown. This lateral fasciole is somewhat broadest as it crosses the posterior extremity of the test (Pl. XXXIV. fig. 4).

The concentration of primary tubercles above the subanal beak to form an indistinct subanal fasciole is very marked. These tubercles pass from primaries to secondaries, and then to miliaries. It is the only case known to me of a closed area thus changed into a plastron surrounded by what corresponds to a fasciole, but made up of primary tubercles. The formation of an ambital fasciole in *Phormosoma* by the concentration of secondary tubercles seems to be an analogous case to this. Only two genital openings are developed (Pl. XXXIV. fig. 2); the apical system is disconnected; there are probably three intercalated interambulacral plates separating the bivium from the trivium, but owing to the

absence of genital pores, it is difficult to analyse this apical system with certainty. The arrangement of the primary tubercles is much like that of *Cystechinus;* from two to five primary tubercles, varying considerably in size, occupy the coronal plates both of the ambulacral and interambulacral areas on the abactinal side. The spines vary greatly in shape in different parts of the test (Plate XXXIV. figs. 11*a–f*). The cluster of primary tubercles of the posterior abactinal region of the test above the anal system, carry paddle-shaped radioles (Pl. XXXIV. fig. 11); on the anterior part of the test and the ridge extending to the apical system they are more elongate, often sharp (Pl. XXXIV. figs. 11*a*, *d*). The same diversity is also found on the actinal side, where the paddle-shaped primary radioles are concentrated on the actinal keel and near the posterior extremity; the tubercles of other parts of the actinal surface, carrying very differently shaped radioles. The miliaries are uniformly scattered over the test, distant, carrying short, slender sharp spines.

Fayal; 2650 fathoms. May 27, 1873.

Palæotropus.

Palæotropus, Lovén, 1874, Études sur les Echinoïdées, p. 17 (Kongl. Svensk. Vet. Akad. Handl., vol. xi. No. 7).

The systematic position of the deep-sea genera allied to *Palæotropus* in having simple ambulacra, extending from the actinostome to the apical system, suggests for criticism the relationship of all the other Spatangoids when tested by this character alone. The genera, which like *Palæotropus, Pourtalesia, Echinocrepis, Spatagocystis, Cystechinus,* and *Urechinus* have only simple pores extending from the actinostome to the apical system in all the ambulacra differ from all the other Spatangoids living and fossil (except it be genera like *Infulaster*, of which the structure of the ambulacra is not well known). Some of the Spatangoids proper are characterised by the difference in structure of the anterior ambulacrum and the lateral ambulacra; such genera, for instance, as *Brissus, Meoma, Faorina, Desoria,* and *Brissopsis,* in which in the anterior ambulacrum the pores are brought together and extend singly from the apex to the actinostome (except immediately round the actinostome where the pores are separated again). In others as in *Hemiaster, Palæostoma, Schizaster, Spatangus* and *Plagionotus* the pores are separated near the apical system in all the ambulacra within the peripetalous fasciole, while they are so separated within the fasciole only in the lateral ambulacra of the former group, and in both groups they are simple again below the peripetalous fasciole.

In genera without distinct petals, such as *Linopneustes, Paleopneustes, Homolampas, Argopatagus* and *Genicopatagus* the arrangement of the pores in all the ambulacra closely resembles that of such genera as *Collyrites, Ananchytes,* and *Holaster,* while in *Micraster* we have the first indication of the specialisation found in the group to which *Hemiaster, Spatangus, Palæostoma,* and the like belong.

Among the older genera *Hemipneustes,* and among the recent genera *Agassizia,* on

the contrary, may be regarded as combining the characters of the two groups; in *Agassizia* the posterior lateral ambulacra having the usual petaloid structure, while the anterior pair of ambulacra are only petaloid in the posterior half, the anterior half retaining the characteristic features usually found only in the anterior ambulacra, and this genus having in addition the embryonic features of a globular test and ambulacra flush with the test; in *Hemipneustes* the double structure of the petals extends to all the lateral ambulacra. In *Echinocardium, Breynia,* and *Lovenia* we find, with the internal fasciole, that the structure of the pores is again simple, while in all the ambulacra the petals correspond to that of the group to which *Hemiaster* and the like belong.

Yet in all the young of true Spatangoids I have had occasion to examine, the ambulacra consist of simple pores, extending from the apical system to the actinostome, the change which characterises the groups thus spoken of taking place very gradually with advancing age. The pairs of pores such as we find in the Cassidulidæ can be traced directly to the affinity of the Cassidulidæ to such groups as *Holectypus* (which in their turn retain features of the Desmosticha), and while the ambulacra assume a more or less petaloid shape, yet the pores never come together into a single foramen. The earliest known Spatangoids (*Collyrites?*) retain this feature, and it is still found at the present day existing to a certain extent in *Homolampas, Argopatagus,* and *Genicopatagus,* which differ, however, from these earlier types in having the well-developed labiate Spatangoid actinostome, and seem to hold from the structure of their ambulacral system much the same relation to the Spatangina which *Hemipneustes* does to *Ananchytes* and *Agassizia* to the Brissina.

**Palæotropus lovéni* (Pl. XXI. figs. 3–16; Pl. XXXIX. fig. 33; Pl. XLI. figs. 28, 29).

Palæotropus Lovéni, A. Agassiz, Proc. Am. Acad., vol. xiv. p. 204.

The anal system is placed above the median line (Pl. XXI. figs. 3, 5), above the angle made by the curve of the posterior extremity of the test extending from the apex, and that extending from the actinal surface along the subanal shield. The anal system is elliptical, transverse (Pl. XXI. fig. 8), surrounded by an outer row of large plates, the rest of the system covered by plates irregularly arranged. The plates of the apical system are indistinct (Pl. XXI. figs. 12, 13); the madreporic body is prominent; there are three genital openings. The larger primary tubercles are perforate, crenulate (Pl. XXI. fig. 16); and the test is covered by a dense minute granulation between the primaries and secondaries. Although *Palæotropus* has the rudimentary ambulacral system, simple pores perforating the primary ambulacral plates as we find them in *Pourtalesia*, it yet has a simple compact apical system; the ambulacra are not disconnected as in that group at the summit by the encroachment of large distinct interambulacral plates extending from the ambulacral area across the apical region so as to separate the bivium

from the trivium. This species differs from the West Indian *Palæotropus josephinæ*, Lov., in being more elongated, in having its greatest breadth near the posterior extremity (Pl. XXI. figs. 3, 4). The apical system is anterior (Pl. XXI. fig. 3); the apex, on the contrary, is posterior, immediately above the anal system (Pl. XXI. fig. 5). Seen from the actinal side the outline is somewhat pentagonal with rounded angles (Pl. XXI. fig. 4). The actinostome is transverse, very slightly sunken, scarcely labiate (Pl. XXI. fig. 15), and strengthened by half a dozen large marginal plates (Pl. XXI. fig. 8^a) with a few irregular smaller plates adjoining the opening; the actinal plastron is large, covered by large primary tubercles diminishing in size towards the subanal fasciole; the field enclosed by it is closely crowded by primary tubercles (Pl. XXI. fig. 8). The anterior part of the test on the actinal surface is covered by small primaries, extending somewhat above the ambitus (Pl. XXI. fig. 5) where the tuberculation of the rest of the abactinal surface becomes uniform in size (Pl. XXI. fig. 3), the tubercles of the interambulacral areas being larger.

Seen from the anterior extremity (Pl. XXI. fig. 6) there is a row of large primary tubercles in the interambulacral spaces extending from the ambitus to the apical system, which are covered with spines; the posterior part of the abactinal surface is comparatively bare, carrying minute silk-like spines, gradually increasing in size towards the edge of the ambitus, so that when seen in profile the sides of the test sloping towards the actinal surface are quite thickly covered by long slender spines. The spines also increase in length and size towards the anterior part of the abactinal surface, and are quite prominent in the region adjoining the anterior ambulacral zone (Pl. XXI. fig. 11). On the actinal side the spines are closely packed except along the lines of the lateral ambulacral areas, which are left comparatively bare.

The spines within the subanal plastron form a prominent tuft, either when seen in profile (Pl. XXI. fig. 9) or from the actinal side (Pl. XXI. fig. 10). The test is extremely thin, of a delicate pink colour, with brownish-pink spines.

Lovén's individual was a young specimen measuring only about 11 mm., while the smallest specimens collected by the Challenger measured more than 15 mm., and, with the exception of a somewhat less elongate and more globular test posteriorly, agreed well with larger specimens.

Station 210. January 25, 1875. Lat. 9° 26′ N., long. 123° 45′ E.; 375 fathoms; bottom temperature, 12·2° C.; mud.

Holasteridæ.

Sub-family Holasteridæ, Pictet.

It seems at present most natural to place the genera *Homolampas*, *Genicopatagus*, *Argopatagus*, *Palæopneustes*, and *Linopneustes* among the Holasteridæ rather than with the Spatangidæ, but I am not inclined to assign to the Holasteridæ the high rank which

both De Loriol and Zittel have like Pictet assigned to the group. The characters of the recent genera show a far closer affinity between the Holasteridæ and the Spatangidæ than had been suspected from the study of the fossil species alone, and for similar resons I should hardly wish to adopt the group *Palæostoma* of De Loriol characterised by the pentagonal actinostome alone, a structural feature which in such genera as *Paleopneustes*, *Aceste*, *Aërope*, and the like is shown to pass so insensibly into the labiate actinostome of the Spatangoids as scarcely to justify us in adopting it as a character for the distinction of higher groups.

**Argopatagus.*

Argopatagus, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 209.

This genus is closely allied to *Homolampas;* it has like it a subanal fasciole (Pl. XXXII. figs. 2, 4), but no peripetalous fasciole; the primary tubercles both on the ambulacra and interambulacra are largest and most crowded at the ambitus; they become less numerous towards the abactinal pole, and smaller though numerous towards the actinostome. The odd anterior ambulacrum is not sunken, but like the others flush with the test. The structure of the ambulacra is similar to that of *Homolampas*, but on the abactinal surface the ambulacral plates are larger in comparison with the interambulacral ones than in that genus; they are all more or less hexagonal. The primary tubercles are more numerous in the odd anterior ambulacrum on the abactinal side (Pl. XXXII. fig. 1). The structure of the apical system is like that of *Homolampas*, it is compact (Pl. XXXII. fig. 6); there are four genital openings enclosing a distinct madreporic body, the sutures of the genital plates are obliterated, the genitals are equally developed. The five or six ambulacral suckers near the abactinal pole are more powerful with small sucking disks, the other suckers rapidly becoming more slender towards the ambitus. These large ambulacral suckers (Pl. XXXII. fig. 6) form a rudimentary petaloid area much as in embryo Spatangoids, but not by any actual petaloid arrangement of the pores.

**Argopatagus vitreus* (Pl. XXXII. figs. 1–6; Pl. XXXVIII. fig. 25; Pl. XXXIX. fig. 18; Pl. XLI. figs. 32–35).

Argopatagus vitreus, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 209.

In this species the test is greatly flattened, extremely thin, transparent, of a yellowish colour. The large primary spines of the abactinal region are cylindrical, curved, of a silvery lustre, with distant sharp spinules along the shaft. The test is quite flattened (Pl. XXXII. fig. 3), and at first sight reminds one when seen from above somewhat of *Maretia*. There were only very imperfect specimens of this species collected, the actinal plastron was missing in all, but as far as the actinal side was preserved (Pl. XXXII. fig. 2), the primary tubercles of that side were smaller than on the upper side and clustered together near the ambitus, forming elongate triangular patches in the

interambulacral spaces between the broad bare ambulacral areas. The spines of the actinal surface are more slender, club-shaped and hollow, while in the spines of the abactinal region the shaft, although hollow, was quite thick.

The secondary spines resemble the primary ones of their corresponding surfaces; the miliary spines are short and straight; there are few small globular pedicellariæ on short-stems scattered round the actinostome and near the ambitus on the actinal side. Seen from above the outline is elliptical (Pl. XXXII. fig. 1), truncated anteriorly, the apex and apical system coincident, the apical system being slightly posterior. The test arches very regularly from the apex towards both the anterior and posterior extremities (Pl. XXXII. fig. 3); the actinal surface is quite flattened, the actinostome elongated, (Pl. XXXII. fig. 5), placed near the anterior extremity (Pl. XXXII. fig. 2).

The test is so thin that the radiating and circular canals can be seen through it round the actinostome (Pl. XXXII. fig. 5). The anal system is placed above the actinal surface in the ambitus, the subanal fasciole extending on to the actinal surface (Pl. XXXII. fig. 2). The subanal fasciole forms a horizontal line with two re-entering loops (Pl. XXXII. fig. 4) below the circular anal system. This is covered with miliaries and short-stemmed club-shaped pedicellariæ. The actinostome is surrounded by a fringe of large tufted tentacles (Pl. XXXII. fig. 5).

Station 191. September 23, 1874. Lat. 5° 41′ S., long. 134° 4′ E.; 800 fathoms; bottom temperature, 3·9° C.; mud.

**Genicopatagus.*

Genicopatagus, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 210.

This genus has striking affinities with *Holaster*, *Cardiaster*, and *Toxaster;* the ambulacra, as in *Toxaster* are all slightly sunken, but the structure of the ambulacra is like that of *Cardiaster*, while in outline it recalls *Holaster*. In the structure of the ambulacral system of the actinostome *Genicopatagus* is closely related to *Paleopneustes;* it differs from it in having the odd ambulacrum rudimentarily petaloid (Pl. XXXI. fig. 16) like the lateral ambulacra, also in having the uniformly-sized plates composing the ambulacra above the ambitus continued to the actinostome. A similar uniformity of structure in the plates composing the interambulacral areas of the actinal and abactinal region also distinguishes this genus from *Paleopneustes* (Pl. XXXV.[a] figs. 1, 2). The position of the anal system is similar to that of *Paleopneustes;* but while having the actinostome of that genus and its general facies, it has not its strongly-marked Spatangoid actinal surface, having no actinal plastron, and an abactinal system, which while not disconnected is yet made up of large genital plates in striking contrast to the compact apical system of *Paleopneustes.*

The madreporic body covers the greater part of the right anterior genital plate. In this species the largest specimen examined showed only a single genital opening

(Pl. XXXV.[a] fig. 2). The most striking feature perhaps of this genus is the small number of coronal plates composing the test, particularly in the interambulacral areas. This genus holds to the Spatangoids in that respect, much the same relation which *Cidaris* holds to the normal Echinids. The number of plates of the ambulacral area is comparatively small also, but not more so than we have found to be the case in *Cystechinus,* compared with the number of interambulacral plates.

In fact, in the latter there is less disproportion in the number of the plates of the two areas, although the number of plates is larger, the ambulacral plates are proportionally larger. The ambulacra are all identical in structure, the odd ambulacrum not differing from the lateral ambulacra in structure, but in having a less number of small plates with double pores, the double pores giving to the ambulacra above the ambitus the least possible petaloid appearance much as in *Argopatagus.* The apical system is more like that of *Cardiaster,* not being so elongated as in *Holaster;* there are four large adjacent interambulacral plates occupying the whole of the apical system. It has, like *Cardiaster* and *Holaster,* a very prominently labiate actinostome ; the position of the anal system is like that of *Toxaster,* while the flat actinal surface and the globular outline remind one of *Cardiaster;* the actinostome is more central than in that genus. Like the typical *Paleopneustes* this species possesses no fascioles. This might perhaps be called an eminently Galeritid Spatangoid.

**Genicopatagus affinis* (Pl. XXXI. figs. 12–22 ; Pl. XXXV.[a] figs. 1–4 ; Pl. XXXIX. fig. 20 ; Pl. XLI. figs. 38, 39 ; Pl. XLIII. fig. 13 ; Pl. XLV. figs. 20–24).

Genicopatagus affinis, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 210.

In this species the primary tubercles on the abactinal side of the test are irregularly placed on the interambulacral plates, occupying more the central portion of the plates (Pl. XXXV.[a] figs. 2, 4), the secondary tubercles scattered between them are somewhat more numerous than the primaries. On the ambulacral plates there are from one to three or four minute primary tubercles (Pl. XXXV.[a] figs. 1, 2, 4) with a corresponding number of miliaries according to the size of the plates. The spines are straight, cylindrical, rather short, larger on the actinal side (Pl. XXXI. figs. 12, 13), where the primary tubercles are larger and are arranged in somewhat regular transverse rows on the interambulacral plates (Pl. XXXV.[a] fig. 2).[1] The ambulacral plates of the actinal surface are bare, carrying only miliary or few secondary tubercles ; the posterior lateral ambulacra form wider bare areas than the others which are somewhat narrower (Pl. XXXV.[a] fig. 1).

The colouring of this species is very various, some of the specimens were violet, while others from the same locality were of a dirty yellowish-green. One of the yellowish-

[1] Ooster has figured the spines of allied fossil genera of Holasteridæ, which show a great similarity to those of *Genicopatagus.*

green specimens had a higher test than the violet specimens, which were all much flatter; otherwise no specific differences were noticed. The plates of the anal system all carry a small secondary tubercle, and the anal opening extends into a short conical projection (Pl. XXXV.[a] fig. 3). The actinostome is elongated, transverse, with a well-marked raised posterior labial edge; the actinal membrane is strengthened by a number of small plates arranged in irregular concentric rows; the structure of the actinal plastron is well shown in Plate XXXI. fig. 1. The shape of the test varies considerably in the few specimens collected; the youngest specimens (Pl. XXXI. figs. 20–22) show when seen from above an angular outline, with a comparatively conical outline when seen in profile, and rather distant spines. In a somewhat older specimen the outline seen from above is nearly circular (Pl. XXXI. figs. 16, 17), the apex with the apical system is posterior (Pl. XXXI. fig. 16). When seen in profile it is high (Pl. XXXI. fig. 19), the test sloping gradually towards the anterior extremity and more suddenly towards the posterior extremity; the anal system is placed high above the ambitus (Pl. XXXI. fig. 18). These young specimens of *Genicopatagus* would readily pass for the young of a *Paleopneustes* (allied to the Florida species) were it not for the different structure of the apical system, from their general outline and from the total absence of any fasciole. The more ordinary outline of the test when seen in profile is represented in Plate XXXI. fig. 14, which shows a much more flattened test and a rudimentary, rounded anal keel below the anal system (Pl. XXXI. fig. 15). The anal system is also, in this older specimen, nearer the ambitus than in the specimen of Plate XXXI. figs. 16–19; while in the youngest specimens it is placed immediately above the ambitus (Pl. XXXI. fig. 20). The outline of these older specimens seen from above does not differ materially from that of the younger more conical specimens; the anal extremity is somewhat more pointed (Pl. XXXI. figs. 12, 13).

Station 157. March 3, 1874. Lat 53° 55′ S., long. 108° 35′ E.; 1950 fathoms; diatom ooze.

Homolampas.

Lissonotus, A. Agassiz, 1869, Bull. Mus. Comp. Zool., vol i. (*non* Schönh).
Homolampas, A. Agassiz, 1872, Revis. Ech., part 1, p. 137.

I have already alluded in the Revision of the Echini to the similarity in structure of the abactinal ambulacral region of *Homolampas* to that of *Cardiaster* and *Holaster*. In the large species (*Holaster fulva*) discovered by the Challenger, the close affinity of the genera is still more evident. *Homolampas* has very rudimentary petaloid ambulacra; it has a peripetalous fasciole which corresponds to the lateral fasciole of *Cardiaster*, having, like it, nothing exactly limiting the ambulacra until they nearly reach the ambitus, where its lateral fasciole would occupy homologically the position of a peripetalous fasciole, and pass below the anal system, though in reality it is a lateral fasciole as we understand it among the recent genera. The next

step is the appearance of a limited subanal fasciole or of a subanal fasciole with anal branches; something like this we find in *Homolampas*. In *Homolampas fragilis* we have an indistinct anal fasciole branching from the subanal fasciole, the peripetalous fasciole evidently developing only at a late stage. This genus has on the whole more important embryonic features than other Spatangoids of which the development is known; *Hemiaster* and *Schizaster*, it is interesting to note, show quite a marked difference in the appearance of the fascioles if we can judge from the two species of *Hemiaster* thus far discovered. Yet while in the genus *Homolampas* the structure of the ambulacra show such embryonic features as to connect it with some of the most typical of the Cretaceous Echinoderms, there are other features which in their turn give it a most modern facies. These are the highly specialised subanal fasciole, the compact abactinal system which the genus has in common with *Paleopneustes*, *Linopneustes*, *Argopatagus*, and other Spatangina not possessing petaloid ambulacra; the development of its primary tubercles as in *Lovenia*, and the well-defined actinal plastron and specialisation of the tubercles of the actinal surface. The resemblance of the miliary tuberculation of *Homolampas fulva* to that of *Spatangus loncophorus*, Meneg., figured by Dames (1877, Palæontog., vol. xxv., pl. ix. fig. 6), is very remarkable, and were it not for the singularly well-developed petaloid ambulacra of the Tertiary species, we could most readily assign it to the genus *Homolampas* from the outline of its test, as the delicate peripetalous fasciole would very easily escape notice unless the specimens were in an extraordinary state of preservation. Unfortunately, nothing is known of the structure of the actinal surface of that species.

Argopatagus and *Homolampas* agree in having a flattened test, a labiate actinostome, and a well-developed subanal fasciole, and in having the typical Spatangoid embryonic ambulacra such as are characteristic of the Cretaceous genera *Holaster* and *Cardiaster* and other Ananchytidæ; while in *Genicopatagus*, with which both *Argopatagus* and *Homolampas* are closely allied, the outline of the test resembles to a remarkable degree that of *Holaster* and its allies.

**Homolampas fulva* (Pls. XXIV., XXXVIII. fig. 26).

Homolampas fulva, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 209.

Although this is a gigantic species compared to the small *Homolampas fragilis* which I described from among the Echinids dredged by Mr Pourtalès in the Straits of Florida, I do not hesitate to refer it to the genus *Homolampas* in spite of the very rudimentary petaloid structure of the abactinal part of the lateral ambulacra. This species has all the other features characteristic of the genus, such as the slightly sunken anterior ambulacrum, the deeply indented test at the edge of the anterior extremity, the very elongated lateral posterior ambulacra, the presence of a subanal fasciole, the position of the anal system, and of the actinostome, the structure of the actinal surface, and especially the presence of huge primary tubercles like those of *Lovenia* in the abactinal part of the interambu-

lacral areas. As many of the characters which distinguish *Homolampas fragilis* from *Homolampas fulva* are mainly due to age, such as the absence of rudimentary petals in *Homolampas fragilis*, the small number of very large primary tubercles, the difference in the outline of the subanal fasciole, and the presence of a thread-like peripetalous fasciole, I will make no immediate comparison between them. *Homolampus fulva* is a large species measuring no less than 95 mm. in length. Seen from above the test is elongated, heart-shaped, deeply indented (Pl. XXIV. fig. 2) at the odd anterior ambulacrum, with a sharp cut immediately above the anal system (Pl. XXIV. fig. 2) in the median interambulacral space. Seen in profile the test is depressed, rises abruptly at the rounded anterior extremity (from the flattened actinal surface) to the rounded apex, which is placed near the anterior extremity, about one-quarter of the distance from the anterior edge of the test to the posterior edge, thence it slopes very gradually towards the posterior extremity, to the abactinal edge of the anal system, which is placed in the anteriorly truncated posterior extremity. The ambulacral areas widen very rapidly from the apical system towards the ambitus, where they attain their greatest width (Pl. XXIV. figs. 1, 2, 8). On the abactinal surface the plates of the ambulacral, and of the lower part of the interambulacral areas, are covered by minute secondary tubercles and miliaries; the abactinal part of the interambulacra carry, however, a few large primary tubercles entirely out of proportion to the tuberculation of the rest of the abactinal surface. In the lateral anterior ambulacra the anterior row of plates is covered by large secondaries, and the posterior row by small primaries, from the apical system to the ambitus, the same tuberculation extending on the actinal surface of these zones to the actinostome. On this actinal surface large primary tubercles commencing at the abactinal part of the ambitus, are arranged in a close pavement of uniform size over the whole anterior lateral part of the test, and over the actinal plastron (Pl. XXIV. fig. 3). The lateral posterior ambulacra with the odd ambulacrum above, are covered with the minute tuberculation so characteristic of the sides of the test above the ambitus. The primary tubercles of the actinal region are surrounded by a large sunken area (Pl. XXIV. fig. 9), the intertubercular spaces are filled with secondaries. Seen from the interior of the test, the larger tubercular depressions form a pavement of rings more or less perfect (Pl. XXIV. fig. 10), much like the pavement of the purses in the interior of *Lovenia*. The same purses, somewhat less developed, are found in the interior of the test below the corresponding primary tubercles of the lateral anterior and posterior ambulacra (Pl. XXIV. fig. 8), the sunken areas round these primaries are not so marked as on the actinal surface. The secondary tubercles carry short curved spines, forming a close covering over the whole abactinal surface, from which stand out the gigantic curved spines of the large primary tubercles (Pl XXIV. fig. 2).

On the actinal side the spines of the primary tubercles are somewhat shorter than those of the larger curved spines of the abactinal surface; they are spathiform and closely

packed together (Pl. XXIV. fig. 3). The lateral posterior ambulacra and the odd ambulacrum are covered by minute miliary spines similar to the secondary spines of the abactinal surface.

The subanal fasciole is broad, pentagonal, pointed towards the actinal surface; the anal system is vertically elongate covered by a close granulation, the anal opening is near the abactinal extremity (Pl. XXIV. fig. 6), the intestine leading to this is short and slender (Pl. XXIV. fig. 5).

There is a very narrow thread-like peripetalous fasciole extending across the tip of the lateral petals in the odd posterior interambulacrum and the lateral posterior interambulacra, which becomes lost in the lateral anterior ambulacra (Pl. XXIV. figs. 1, 2).

The abactinal system is compact; the sutures between the genital plates are entirely obliterated; there are four genital openings (Pl. XXIV. fig. 12) leading to four equally developed genital glands, forming short grape-like clusters near the abactinal system (Pl. XXIV. fig. 6). The madreporic body extends between the genital openings, and beyond them in the posterior interambulacrum (Pl. XXIV. fig. 12). Seen from the interior of the test, the calcareous canal forms a couple of loops for the passage of the genital ducts (Pl. XXIV. fig. 7). The actinal opening is pentagonal, pointed anteriorly, slightly labiate posteriorly; the actinal membrane is strengthened by small plates regularly arranged (Pl. XXIV. fig. 11); the actinal tufted tentacles are comparatively small.

The abactinal system of *Homolampas* closely resembles that of *Paleopneustes;* it also agrees with it in having the actinal surface eminently Spatangoid, while the abactinal surface from the presence of rudimentary petals and simple ambulacral pores with comparatively large ambulacral plates, recalls the *Pourtalesia* group proper. The presence of a well-defined subanal fasciole and of a lateral fasciole, as well as the presence of specially developed primary tubercles, also places this genus closer to the normal Spatangoids. The young of this genus, as in *Homolampas fragilis,* shows better than in such large species as *Homolampas fulva* the affinities of the genus to *Palæotropus;* from this genus it mainly differs in the greater specialisation of the ambulacra, and the presence of a peripetalous fasciole and a more labiate actinostome.

In alcohol the test is of a light straw colour.

Station 271. September 6, 1875. Lat. 0° 33′ S., long. 151° 34′ W.; 2425 fathoms; bottom temperature, 1·0° C.; globigerina ooze.

Homolampas fragilis.

Lissonotus fragilis, A. Agassiz, 1869, Bull. Mus. Comp. Zool., vol. i.
Homolampas fragilis, A. Agassiz, 1872, Revis. Ech., part 1, p. 137.

Only a fragment of this species was collected by the Challenger, off the coast of Northern Brazil.

Station 122. September 10, 1873. Lat. 9° 5′ S. to 9° 10′ S., long. 34° 49′ W. to 34° 53′ W.; 350, 120, 32, and 400 fathoms; mud.

**Linopneustes* (*Paleopneustes*).

Paleopneustes, A. Agassiz, 1873, Bull. Mus. Comp. Zool., vol. iii. No. 8, p. 188.

Since the preliminary examination of the specimens associated as *Paleopneustes murrayi*, A. Agassiz,[1] I have referred to the same species a couple of smaller specimens which throw considerable light on the specific characters of this species, and show that both the peripetalous fasciole and the subanal exist in the smallest specimen examined (Pl. XXXV.[b] fig. 9), so that it seems best for the present at least to place this species in a sub-genus of *Paleopneustes* (*Linopneustes*) differing from *Paleopneustes* in having both a peripetalous and a subanal fasciole, until we know something more of the changes due to growth in *Paleopneustes* proper. I am the more inclined to do this as the typical *Paleopneustes*, forming as it does a link between the Ananchytidæ and Spatangidæ, appears fossil in the Tertiaries, Dames[2] having described a species of *Paleopneustes*, which differs from the recent West Indian species in being more elongated and having a flattened test and more petaloid ambulacra, resembling, in fact, more in its outline the smaller specimens of *Linopneustes murrayi*, in which the test is comparatively flatter than in the older stages, agreeing also with those younger stages in having fewer and proportionally larger tubercles on the abactinal side of the test. The sub-genera *Linopneustes* and *Paleopneustes* stand related to each other much as *Pericosmus* and *Macropneustes* do as far as relates to the existence of a peripetalous fasciole.

The relations between *Paleopneustes*, *Linopneustes*, *Platybrissus* and *Eupatagus* are extremely instructive; as I stated in the description of small specimens of *Linopneustes murrayi*, these resemble *Eupatagus* in having a peripetalous and a subanal fasciole, they agree, however, with *Paleopneustes* in not having petaloid ambulacra. The flattened tests of *Platybrissus* and of *Eupatagus* connect them with the younger stages of *Linopneustes*, and the facies of tuberculation of *Linopneustes* agrees well with that of *Platybrissus*, while *Platybrissus* and the typical *Paleopneustes* agree in not having fascioles, while the semipetaloid anterior lateral ambulacrum of *Platybrissus* forms the passage between such petaloid ambulacra as we find in *Paleopneustes*, *Asterostoma*, and *Oviclypeus*, and the petaloid ambulacra of *Eupatagus*, *Spatangus*, *Maretia*, *Nacopatagus*, and the like, the petals of which are all more or less open at the extremity and sometimes even show a slight tendency to divergence.

It seems evident from the descriptions of Cotteau and D'Orbigny that there are two distinct types in *Asterostoma*, one of which may prove identical with the typical *Paleopneustes*,[3] while the other type is represented by what Dames has called *Oviclypeus*,[4] which has the peculiar ambulacral furrows on the actinal surface mentioned by Cotteau in his original description of the genus *Asterostoma*.

[1] A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 210.
[2] Dames, 1877, Palæontog., vol. xxv. pl. viii. fig. 1.
[3] A. Agassiz, 1874, "Hassler" Zool., Results, Ill. Cat. Mus. Comp. Zool., No. 8.
[4] Dames, 1877, Palæontog., vol. xxv. pl. x. fig. 1.

In *Linopneustes* the pedicellariæ (Pl. XLIII. figs. 6–8 ; Pl. XLV. figs. 11–19) do not greatly differ from the pedicellariæ of *Paleopneustes*, and are remarkable for the great size of the spaces left between the valves of the head.

**Linopneustes murrayi* (Pls. XXV., XXXV.[b] figs. 8, 9 ; Pl. XXXVIII. figs. 24, 28, 29 ; Pl. XLIII. figs. 6, 8 ; Pl. XLV. figs. 11–19).

Paleopneustes Murrayi, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 210.

It was with considerable doubt that I referred this species to *Paleopneustes*. The presence of a subanal fasciole and a peripetalous fasciole would at first seem to remove it from *Paleopneustes*, with which it agrees in its general features, such as the structure of the ambulacral petals, of the actinostome, and of the actinal side of the test. The series collected is composed mainly of large specimens varying in size from 80 mm. to 130 mm. ; in some of them the subanal fasciole is most indistinct, consisting merely of an occasional accumulation of miliary tubercles, and the same is the case with the peripetalous fasciole which is in some cases interrupted by breaks, or so diffuse as to lose its distinctive character as a fasciole. So much weight has been laid upon the presence or absence of this fasciole especially in the fossil genera, which had been multiplied now to an extraordinary degree, that a careful study with large material in all possible stages of growth of some of the recent genera such as *Hemiaster Shizaster*, *Faorina* and *Maretia* would go far to determine whether the presence or absence of fascioles really has the systematic value attached to it. In the species of *Hemiaster* which I have had occasion to study, the changes undergone by the fascioles during growth are remarkable and the variations in the extent and importance of the fasciole extreme. See the descriptions of *Hemiaster cavernosus* collected by the Challenger.

From the specimens of *Paleopneustes* proper collected by the "Blake" very great changes in general appearance evidently take place during growth, and it may be that the fragments of a species of Spatangoid which I regarded in the report on the "Blake" Expedition (Echini, Bull. Mus. Comp. Zool., 1878, vol. v. No. 9) as intermediate between *Eupatagus* and *Paleopneustes*, may be perhaps only a species of *Paleopneustes* allied to *Linopneustes murrayi*, having like it a very prominent peripetalous fasciole more marked even than in any specimen of that species I have had occasion to examine. I have called attention to the unsatisfactory state of our knowledge of the value of fascioles while speaking of some species of *Maretia* and of *Lovenia*, from which it would almost appear as if disconnected lengths of fascioles might appear anywhere on the test provided the miliaries of that portion of the test were sufficiently crowded together.

A fragment of a large specimen was obtained at Station 210 in which the peripetalous fasciole is quite close to the ambitus, running immediately on the edge of the test, and in which the anterior ambulacral groove is somewhat deeper than in the specimens from Japan. Around this there are from three to four smaller lines of fascioles made by the

miliary tubercles arranged in lines between the primary tubercles. This structure is very marked in young specimens, and plainly shows the manner in which the fascioles pass from miliary tubercles into the regular fascioles.

This species differs from the West Indian species in having a more flattened test, and better defined petaloid ambulacra; in having a subanal and a peripetalous fasciole; and in having far larger and longer primary spines differing greatly in size on different parts of the test; while in *Paleopneustes cristata* the spines covering the abactinal part of the test are remarkably uniform, with the exception of the tuft of primary spines near the apex.

Seen from above the test is elliptical; the odd ambulacrum is slightly sunken at the ambitus, the median odd interambulacral space also re-entering immediately above the anal system (Pl. XXV. fig. 1). Seen in profile (Pl. XXV. fig. 3) the apical system and apex coincide; the apical system is central, and from this the test arches regularly towards the anterior and posterior extremities, sloping more rapidly towards the posterior extremity, and being more gibbous towards the anterior extremity. The posterior extremity is truncated from the anal system placed above the actinal surface (Pl. XXV. figs. 3, 5). The actinal surface is flat, with the exception of the slightly sunken anterior ambulacrum, and the slight keel formed by the actinal plastron, which projects but little beyond the general level of the actinal surface (Pl. XXV. figs. 2, 4). The actinostome is excentric, placed towards the anterior extremity (Pl. XXV. fig. 2) about one-third of the length of the test. It is elongated, transverse, with a prominent actinal lip (Pl. XXV. fig. 7) with broad ambulacral plates, separated at the edge of the actinostome by exceedingly narrow interambulacral plates; with the exception of the broad plate forming the lip, the actinal membrane is strengthened by two irregularly concentric rows of numerous triangular plates; the actinal opening is close to the posterior edge of the actinostome.

The anal system is circular, covered by numerous plates forming four or five irregular concentric rows round the anal opening; the outer row of plates are elongated, the others are irregular in shape (Pl. XXV. fig. 6). The extremity of the indistinct rounded actinal keel is surrounded by a broad well-marked fasciole. The peripetalous fasciole extends from the end of the posterior lateral petal, sloping towards the end of the anterior pair where it becomes indistinct; its course is also very poorly defined across the odd interambulacral area. This fasciole is quite narrow and often even the part running between the lateral ambulacra, figured on Plate XXV. fig. 3, is quite indistinct and broken. On the actinal side (Pl. XXV. fig. 2) the tuberculation is limited to the edge of the test adjoining the ambitus mainly in the interambulacral spaces; the tubercles are quite uniform in size, leaving broad, bare ambulacral avenues, slightly tuberculated at the ambitus; round the actinostome (Pl. XXV. fig. 7) there are only miliary or small secondary tubercles (Pl. XXV. fig. 2). On the abactinal surface the tuberculation is very irregular; each coronal plate carries in the interambulacral area a number of primary

tubercles generally crowded towards the upper part of the plate, with secondary and miliary tubercles towards the lower edge (Pl. XXV. fig. 3); the edges of the plates are, however, left quite free from tubercles, the tubercles leaving bare lines to indicate the sutures on each side of them below the rudimentary petals; the tuberculation of the ambulacral area is similar to that of the interambulacral areas, only the tubercles are smaller.

The apical system is compact; the four genital openings large (Pl. XXV. fig. 5), placed close together, well above the ocular plates; the sutures of the genital plates are obliterated; the madreporic body extends into the posterior interambulacrum in a large horse-shoe-shaped form, and extends also anteriorly between the four genital plates.

The ocular plates are triangular, rounded at the apex, with a prominent pit in which is placed the ocular pore. Seen from the interior, the apical system shows the great development of the abactinal part of the calcareous canal (Pl. XXV. fig. 8) with the slender ducts leading from the genital openings to the genital organs.

The ambulacral pores round the actinostome give passage to tufted ambulacral suckers; the ambulacra are simple pores from those to the lower extremity of the rudimentary petals formed by the narrow more elongate ambulacral plates perforated by pairs of pores; these petals flare slightly at the lower extremity, the posterior lateral pair flaring more widely and not extending quite so far towards the ambitus. The odd anterior ambulacrum is simple, and is not petaloid towards the abactinal system. On the abactinal side the primary spines of the interambulacral area are curved, moderately long, the whole test thickly covered with them and the intervening miliaries and secondaries. On the actinal side the spines are somewhat less stout. The spines of the ambulacral areas are smaller on the abactinal surface, and quite minute on the actinal side and in the petaloid region of the ambulacra.

The colour of the test when denuded is reddish-brown, the spines of a brownish-yellow colour, with occasionally lighter-coloured spines.

In younger specimens of *Paleopneustes murrayi* the test is quite flattened, much as in *Maretia* proper; this is contrary to what is generally the case among Spatangoids, where, as in *Brissopsis*, *Spatangus*, *Hemiaster*, *Schizaster*, and young specimens of many other genera, the test is quite globular, and subsequently becomes flattened or assumes the outline of the adult; it is, however, what we have found to be the case in the Ananchytid-like genera such as *Cystechinus*, *Urechinus*, *Spatagocystis*, and also in *Genicopatagus*.

In young specimens measuring about 30 and 40 mm. in length, the ambulacral petals are quite straight, and do not flare at the extremity (Pl. XXXV.[b] figs. 8, 9). The peripetalous fasciole is very distinct, but very thin, a mere line having much the same course as in older specimens such as are figured on Plate XXV. fig. 3, where it is also often reduced to a mere thread, and perhaps eventually disappears, as is the case in the Barbados' species (*Paleopneustes cristata*), in which we have no such fasciole, and in

which the young even do not have any. In fact, the general facies of the younger specimens is more like *Eupatagus* than *Paleopneustes.* The number of large primary tubercles is comparatively small; they are larger, and the abactinal surface is sparsely covered with large curved spines, giving the young specimens the general appearance of a *Maretia,* with few spines (Pl. XXXV.[b] figs. 9, 9[a]). It is only in later stages that the disproportion between the secondary and primary spines disappears, and that the test when covered with spines resembles the specimens figured on Plate XXV.

Station 210. January 25, 1875. Lat. 9° 26′ N., long. 123° 45′ E.; 375 fathoms; bottom temperature, 12·2° C.; mud.

Station 232. May 12, 1875. Lat. 35° 11′ N., long. 139° 28′ E.; 345 fathoms; bottom temperature, 5·0° C.; sandy mud.

Spatangina.[1]

Sub-family Spatangina, Gray, 1855, Cat. Rec. Ech.

Spatangus.

Spatangus, Klein, 1734, Nat. Disp. Ech.

Spatangus purpureus.

Spatagus purpureus, Müll., 1776, Prod. 2850.
Spatangus purpureus, Leske, 1778, Kl. Add., p. 170.

The existence of this species at the Bermudas is interesting as forming a link between the localities from the Eastern Atlantic, where it had been known previously, and its occurrence in the eastern part of the Caribbean Sea, where it has been dredged by the "Blake."

Station 75. July 2, 1873. Lat. 38° 37′ N., long. 28° 30′ W.; 50 to 90 fathoms; sand.

Off Bermudas; 100 fathoms.

Spatangus raschi.

Spatangus Raschi, Lovén, 1869, Öfv. Skand. Vet. Akad. Förh.

This species with its high test and small tuberculation is far more closely allied to the Tertiary species of *Spatangus,* like *Spatangus delphinus,* than to the common *Spatangus purpureus.* Its geographical range is also quite extensive, extending from the northern part of the Eastern Atlantic to the Cape of Good Hope.

Station 142. December 18, 1873. Lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms; bottom temperature, 8·3° C.; sand.

Agulhas Bank; 100 fathoms.

[1] Not *Euspatangina,* A. Agassiz, as in Revis. Ech., p. 219.

Maretia (*Spatangus*).

Maretia, Gray, 1855, Cat. Rec. Ech.

Maretia alta (Pl. XXXVII. figs. 1–4).

Maretia alta, A. Agassiz, 1863, Proc. Ac. N. S. Phila., p. 360.

As there are many excellent figures of *Maretia planulata*, I have figured *Maretia alta* for the sake of facilitating comparison between these two recent species of the genus. The specimens of this species collected by the Challenger show that it becomes considerably larger than was previously known, one of the Challenger specimens measuring 35 mm. in length.

I could find no trace in the specimens examined of the rudimentary lateral fasciole first seen by Duncan[1] in a fossil species of the genus, *Maretia anomala*. It, however, occurs in the recent species of the genus, for among the many specimens of *Maretia planulata* I found that some of them show a very distinct interrupted lateral fasciole, but far less well marked than in *Lovenia*, where I have also detected a similar but a much better defined lateral fasciole and one apparently uniformly present, which is not the case with the rudimentary lateral fasciole of *Maretia planulata*.

Maretia carinata, Bolau,[2] is evidently from its very characteristic description identical with the species I briefly noticed in 1863 in the Proc. Phil. Acad., and subsequently described more fully in the Revision, part 3, p. 569, 1873, as *Maretia alta*.

The presence of only two to three large primary spines near the ambitus on the abactinal surface gives this species (Pl. XXXVII. figs. 1, 4) a very different aspect from that of *Maretia planulata*, in which the whole of the abactinal surface above the ambitus in the paired interambulacral areas is covered by many large primaries carrying long curved spines often equalling in length half the length of the test, with a coarse miliary intertubercular granulation, while the miliary tuberculation of *Maretia alta* is close and fine, the abactinal surface of the test, carrying only very short, slender miliary spines uniformly distributed over the coronal plates. The bare ambulacral fields of the actinal surface are also comparatively narrow in this species, the primary tuberculation of the actinal surface extending nearer towards the actinostome from the ambitus than in *Maretia planulata*. The difference in coloration is also most striking, all the alcoholic specimens of *Maretia planulata* are of a light straw colour, while those of *Maretia alta* are of a dark pinkish-buff colour.

Station 191. September 23, 1874. Lat. 5° 41′ S., long. 134° 4′ E.; 800 fathoms; bottom temperature, 3·9° C.; mud.

Station 192. September 26, 1874. Lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud.

[1] Duncan, 1877, Quar. Journ. Geol. Soc., vol. xxxiii. p. 52.

[2] Dr Heinrich Bolau Die Spatangiden des Hamburger Museums, Hamburg, 1873.

Maretia planulata (Pl. XXXVIII. fig. 23; Pl. XL. figs. 54, 55; Pl. XLI. figs. 17–20).

Spatangus ovatus, Leske, 1778 Kl. Add. (*non* Lamk. *nec* Kl.)
Maretia planulata, Gray, 1855, Cat. Rec. Ech., p. 48.

Admiralty Islands. 16 to 25 fathoms. March 7, 1875.
Port Jackson. 6 to 15 fathoms and 2 to 10 fathoms. April 18, 1874.
Levuka Reef. July, 1874.

Eupatagus (*Spatangus*).

Eupatagus, Agass., 1847, C. R., Ann. Sc. Nat., vol. viii.

Eupatagus valenciennesii (Pl. XXXVII. figs. 5, 6; Pl. XXXIX. fig. 17; Pl. XL. figs. 11, 12).

Eupatagus Valenciennesii, Agass., 1847, C. R., Ann. Sc. Nat., vol. viii. p. 9.

I have given on Plate XXXVII. figures of this species of *Eupatagus* covered with spines. From the size of the broken primary spines of the interambulacral area in the petaloid region of the ambulacra, some of them must have attained a considerable size. These primary spines are curved, and may have been nearly half the longitudinal diameter of the test in length. The spines of the actinal plastron and of the interambulacral areas of the actinal side near the ambitus, are similar to those of the abactinal region, only considerably smaller. The rest of the test, with the exception of the tuft of longer spines near the anal system, is covered by short slender spines of uniform length somewhat distant, increasing in size near the ambitus on the actinal surface. The colour of the test in alcohol is brownish-pink, darkest within the peripetalous fasciole, the primary spines are of a reddish-yellow tint, the smaller ones darker brown, gradually passing towards the edge of the test into the prevailing colour of the test, which is brownish-yellow and dirty yellowish on the actinal side; on the abactinal surface the margin of the coronal plates forms at first a light coloured frame round the darker central part. This eventually becomes quite light coloured, and on the actinal side the test and spines are nearly of the same tint.

Off Port Jackson; 30 to 35 fathoms.

Station 188. September 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E.; 28 fathoms; mud.

Arafura Sea.

Echinocardium.

Echinocardium, Gray, 1825, Ann. Phil. (*pars.*).

The difficulty of properly limiting the genera of Spatangoids is well shown in the different attempts which have been made to limit *Echinocardium*, *Breynia*, *Lovenia*, and

Amphidetus; we are either led to unite these genera into one genus, as has been proposed by Gray, and recognise *Breynia* and *Lovenia* merely as sub-generic types, or we are almost forced to establish for every species a different generic section, so gradually do all the characters upon which these genera are usually distinguished pass into one another.

Breynia, *Echinocardium*, and some species of *Lovenia* correspond remarkably well in the structure of the posterior extremity of the test; while *Breynia* and *Echinocardium* agree well in the structure of the actinal surface, yet in *Echinocardium* we can see the beginning of the sinking of the scrobicular area so specially developed in one of the species of *Lovenia* proper, while in *Breynia* and *Lovenia*, both have a peripetalous fasciole or a partial lateral fasciole, and *Breynia*, *Lovenia*, and *Echinocardium* all agree in the structure of the petals and in having an anterior intrapetalous fasciole. *Breynia* and some species of *Echinocardium* agree in having no unduly developed large primary tubercles below the petals, and the few larger primaries are placed within that area; the large primaries of *Lovenia* on the abactinal surface showing their relationship to *Spatangus*, *Maretia*, and the like; while in such species of *Echinocardium* as *Echinocardium flavescens*, it would be difficult to separate it from *Breynia* except for very unsatisfactory reasons (the shape of the test and the presence of a peripetalous fasciole). The greater number of primary tubercles in the anterior part of the test of these species is, on the contrary, a feature which allies them to *Lovenia* as well as the slight beak formed over the sunken anal system, which is still more prominently developed in *Echinocardium pennatifidum*. As will be seen from the analysis of *Breynia* and *Lovenia* it is evident that these genera and *Echinocardium* are very closely related, and might very properly be considered as sub-genera only of *Echinocardium*.

Echinocardium australe.

Echinocardium australe, Gray, 1851, Ann. Mag. Nat. Hist., p. 131.

A good series of specimens of this species was collected; they show that the characters which have been used to distinguish *Echinocardium australe* from its Atlantic congener, *Echinocardium cordatum*, are reduced to differences in the shape of the anal system, the position of the apical system and the difference in outline of the profile of the test, with the slight difference in the distances of the pores of the petals. These differences are thus far quite constant in all the specimens I have examined, but seem very slight ground for maintaining the specific distinctness of the Pacific and the Atlantic representatives of the genus, and I should expect that additional material will prove this species to be identical with the European species, and to have, like a few other species of Echinids, a most extensive geographical as well as bathymetrical range.

Kobe, Japan; 7 to 8 fathoms.

Station 234. June 3, 1875. Lat. 32° 31′ N., long. 135° 39′ E.; 2675 fathoms; bottom temperature, 1·4° C.; grey ooze.

Port Jackson. 6 to 15 fathoms.
Kobi, Japan. 8 to 50 fathoms. May 18 and 19, 1875.

Echinocardium flavescens.

Spatagus flavescens, Müll., 1776, Prod. p. 235.
Echinocardium flavescens, A. Agassiz, 1872, Revis. Ech., part 1, p. 110.

I am unable to distinguish the specimens of this species collected at the Cape of Good Hope from the northern ones. There seems to be a number of northern species of Spatangoids which extend to the Cape; among them are to be mentioned also *Brissopsis lyrifera*, *Spatangus raschi*, and *Schizaster fragilis.*

Station 142. December 18, 1873. Lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms; bottom temperature, 8·3° C.; sand.

Lovenia (*Echinocardium*).

Lovenia, Des., 1847, C. R., Ann. Sc. Nat., vol. viii.

Lovenia elongata (Pl. XXXIX. fig. 13; Pl. XL. figs. 45, 46).

Spatangus elongatus, Gray, 1845, "Eyre" Voyage, vol. i.
Lovenia elongata, Gray, 1851, Ann. Mag. Nat. Hist.

I may state here that *Lovenia elongata* has been found in the Gulf of California by Dr W. J. Fisher (Mus. Comp. Zool. Coll.), and is thus found associated on the west coast of Central America with *Lovenia cordiformis*, while in the Philippine Islands it is associated with *Lovenia subcarinata.*

Station 188. September 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E.; 28 fathoms; mud.

Station 212. January 30, 1875. Lat. 6° 55′ N., long. 122° 15′ E.; 10, 14, and 20 fathoms; sand.

Simon's Bay.

Lovenia subcarinata (Pl. XXXV.b figs. 5–7).

Spatangus subcarinatus, Gray, 1845, "Eyre" Voyage, vol. i.
Lovenia subcarinata, Gray, 1851, Ann. Mag. Nat. Hist.

Several of the specimens of this species collected by the Challenger are somewhat larger than those previously known. The figures given show at a glance the characters which distinguish this species. The profile view and the abactinal view are specially important as showing the striking difference in the structure of the posterior extremity from that of *Lovenia elongata.* The anal system is small (Pl. XXXV.b figs. 5, 6), and is placed at the upper extremity of a slight depression above the subanal fasciole, placed entirely on the sloping posterior extremity above the ambitus, in striking contrast to the large

deep pit in which the anal system of *Lovenia elongata* is placed. The actinal plastron is quite small, and the primary tubercles with sunken scrobicular areas forming the adjoining pavement, and the outer edge of the bare actinal ambulacral areas are comparatively smaller than in *Lovenia elongata* and more closely packed together (Pl. XXXV.[b] fig. 7).

The large primary tubercles which in *Lovenia elongata* extend from the ambitus to the abactinal region in the anterior interambulacrum, and in the anterior half of the lateral posterior ambulacra, are in *Lovenia subcarinata* limited to two horizontal rows of two and three large primaries (Pl. XXXV.[b] fig. 5) which alone carry stout, long curved spines on the abactinal surface. The rest of the abactinal side of the test is covered by thin, short, slender curved spines, while in *Lovenia elongata* the large curved spines extend over the greater part of the posterior extremity of the test (see pl. xix.[c] Revis. Ech.). The tufts of spines on the two sides of the plastron enclosed by the subanal fasciole consist of somewhat longer spines than those of the abactinal surface, and these tufts consist of much more slender spines than those forming the corresponding tufts of *Lovenia elongata*. The primary spines of the actinal surface are also shorter and comparatively more slender than in *Lovenia elongata*.

This species is also interesting on account of its rudimentary lateral fasciole, which extends close to the ambitus from the anterior ambulacrum to about the median line of the posterior lateral ambulacra. This fasciole is somewhat indistinct, but consists of two to three more or less irregular horizontal lines of small miliary tubercles, differing in no way from the smaller miliaries covering other parts of the test (see Duncan). This seems to show quite conclusively a far closer relationship between *Breynia* and *Lovenia* than had been suspected. In fact, if we are to take *Lovenia elongata* as the typical *Lovenia* and *Breynia australasiæ* as the typical *Breynia*, *Lovenia subcarinata* has, like *Lovenia elongata*, the large primaries with sunken scrobicular areas of the actinal surface, and the same arrangement of the primary tubercles of the anterior part of the abactinal part of the test, while it has the anal system and the whole of the posterior part of the test more like *Breynia australasiæ*, and in addition the rudimentary lateral fasciole, the remnant of the peripetalous fasciole of *Breynia*, which has been considered one of the principal points of difference between it and *Lovenia*.

The existence of a partial lateral fasciole, both in *Lovenia elongata* and in *Lovenia cordiformis*, if we may so call the somewhat irregular band of miliaries extending from the anterior ambulacrum on the abactinal side near the edge of the ambitus towards the posterior extremity, throws considerable light on the origin of the fascioles, and plainly shows that they are at first (at least in *Lovenia* and *Maretia* where lateral fascioles had not been observed) more or less irregular bands of miliary spines, which eventually become specialised and limited to distinct areas. The origin and formation of the subanal fascioles, as well as that of the peripetalous fasciole wherever I have traced it, fully sustains this view. This helps to explain the great variation we find in the degree and

extent of development of the fascioles in species of the same genus and often in specimens of the same species.

Hong Kong, outside harbour. 10 fathoms. December 22, 1874.

Breynia (*Echinocardium*).

Breynia, Des., 1847, Agass., C. R. Ann. Sc. Nat., vol. viii.

See *Lovenia subcarinata*, where I have given an analysis of the affinities of *Breynia* and *Lovenia*.

Breynia australasiæ (Pl. XXI. figs. 1, 2; Pl. XXXIX. fig. 14; Pl. XL. figs. 47–50).

Spatangus australasiæ, Leach, 1815, Zool. Misc., vol. ii. p. 68.
Breynia australasiæ, Gray, 1855, Cat. Rec. Ech.

As in *Eupatagus* the abactinal side of the test is covered with secondary spines of uniform size and of a light chocolate colour, with a silvery lustre in alcohol, with a few large curved primary spines of a lighter colour in the interambulacral abactinal region of the test, near the peripetalous fasciole. The spines increase in size towards the ambitus, and on the actinal side become longer; they are curved towards the bare ambulacral zones both in the lateral interambulacral areas, and in the actinal plastron. In alcohol the colour of the spines of the actinal surface is much lighter than on the abactinal side; the large spines being of a light yellowish tint with a silvery white lustre.

Torres Straits. August 7, 1874.

Brissina.

Sub-family Brissina, Gray, 1855, Cat. Rec. Ech.

Hemiaster.

Hemiaster, Des., 1847, Agassiz, C. R. Ann. Sc. Nat., vol. vii.

Hemiaster cavernosus (Pls. XX.[a], XXXIX. fig. 15; Pl. XLI. figs. 21, 22).

Tripylus cavernosus, Phil., 1845, Wieg. Archiv, p. 347.
Hemiaster cavernosus, A. Agassiz, 1872, Revis. Ech., part 1, p. 132.

In a large specimen of *Hemiaster cavernosus* no trace of a distinct anal fasciole could be detected; there existed, it is true, an accumulation of smaller tubercles all round the anal extremity. In a small specimen, however, measuring only one-third of an inch, there was a distinct anal fasciole joined to a very broad, well-marked lateral fasciole, while in another specimen measuring half an inch the subanal fasciole consisted only of a short arc without any trace of the lateral fasciole. A similar difference also undoubtedly exists in

many species of this family, as has been noticed by Troschel, who, however, considered the presence or absence of any fasciole as of considerable specific and even generic importance. It is evident from an examination of many specimens of this species, that we may have remnants of the lateral and anal fasciole irregularly scattered round the anal extremity either as imperfect anal fascioles or as branches of the peripetalous fasciole or as indistinct subanal and anal fascioles or remnants of the lateral fasciole.

In a young specimen measuring scarcely an eighth of an inch, and in younger stages (Pl. XX.[a] fig. 9), the anal system is placed within the peripetalous fasciole, so that the second or normal stage, as we have it in the adult, is due to the gradual passage of the anal system from this abactinal position to one below the peripetalous fasciole, and the formation of a new peripetalous fasciole inside of the anal system, and thus at one time the anal system was included within a triangular space formed by a branch of the original peripetalous fasciole, and the new base of the same turning across the odd interambulacrum between the anal system and the abactinal system.

These branches are sometimes persistent, and have been also noticed by Troschel, who, however, was not aware of their origin in *Faorina*. This secondary subanal fasciole usually disappears with age, and is not identical with the permanent subanal or anal fasciole which is formed at a later stage, while the other branch if persistent would form a fasciole above the anal system. The great variation existing in the extent and distinctness of the anal fasciole is well shown in the differences found to occur in specimens of various sizes from one and the same locality in *Hemiaster cavernosus*. It is also plain that the anal fasciole, as such, derived its origin from the peripetalous fasciole, while the subanal fasciole is formed independently, and may exist where no peripetalous fasciole is found, as in *Spatangus*, *Maretia*, and the like; and many older genera, such as *Palæotropus*, *Argopatagus*, *Pourtalesia*, and *Urechinus*.

The following description of the manner in which the young are carried in the marsupium formed by the deeply-sunken lateral ambulacra is taken from Thomson's account in the Voyage of the Challenger, vol. ii. p. 231:—"In the female, the pore-plates of the paired ambulacra are greatly expanded and lengthened and thinned out, and depressed so as to form four deep, thin-walled, oval cups sinking into and encroaching upon the cavity of the test, and forming very efficient protective marsupia (Pl. XX.[a] fig. 6 = fig. 44). The ovarial openings are, of course, opposite the interradial areas, but the spines are so arranged that a kind of covered passage leads from the opening into the marsupium, and along this passage the eggs, which are remarkably large, upwards of a millimetre in diameter when they leave the ovary, are passed; and are arranged very regularly in rows on the floor of the pouch, each egg being kept in its place by two or three short spines which bend over it (Pl. XX.[a] fig. 2 = fig. 46). Among the very many examples of this *Hemiaster* which we dredged in Accessible Bay, and afterwards in Cascade Harbour, Kerguelen, there were young in all stages in the breeding-pouches, and although

from the large size and the opacity of the egg and embryo it is not a very favourable species for observation, had other conditions been favourable we had all the material for working out the earlier stages in the development of the young very fully. The eggs, on being first placed in the pouches, are spherical granular masses of a deep orange colour, enclosed within a pliable vitelline membrane, which they entirely fill. They become rapidly paler in colour by the development of the blastoderm; they then increase in size probably by the imbibition of water into the gastrula cavity, and a whitish spot with a slightly raised border indicates an opening which I have no reason to doubt is the permanent mouth, but of this I cannot be absolutely certain.

"The surface now assumes a translucent appearance, and becomes deeply tinged with dark purple and greenish pigment, and almost immediately, without any definite intermediate steps, the outer wall is filled with calcified tissue; it becomes covered with fine spines and pedicellariæ, a row of tentacular feet come into action round the mouth, the vent appears at the posterior extremity of the body, and the young assumes nearly the form of the adult. These later changes take place very quickly, but they are accompanied by the production of so much heavy purple and dark green pigment that it is difficult to follow them. The viscera are produced at the expense of the abundant yelk, and the animals at once take a great start in size by the imbibition of water into the perivisceral cavity. The young urchins jostle one another on the floor of the breeding pouch, those below pushing the others up until the upper set are forced out between the rows of fringing spines of the pouch, but even before leaving the marsupium, on carefully opening the shell of the young, the intestine may be seen already full of dark sand, following much the same course which it follows in the adult. The size of the test of the young on leaving the marsupium is about 2·5 mm. in length by 2 mm. in width."

To give as fully as possible the history of this species the accompanying description of the changes due to growth are reprinted from a notice on the Viviparous Echinids, from Kerguelen Island,[1] describing the early stages of this species.

"The function of the deeply sunken petaloid ambulacra of several genera of Spatangoids, such as *Moira*, *Schizaster*, *Hemiaster* and the like, has thus far remained unknown. Philippi in 1845, while describing some South American Spatangoids, found in the deeply sunken posterior ambulacra of *Hemiaster cavernosus* minute Echinids, which he regarded as the young of the species, though they differed widely from the adults, and seemed, from their shape and the nature of their spines, to approach nearer the regular Echinids than the Spatangoids. Echinids of this genus being but rarely found in collections, no opportunity occurred of verifying the observations of Philippi. A somewhat analogous observation was made by Grube, who described more in detail the young of *Anochanus* (*Echinobrissus*), which he found living under very similar circumstances, in a cavity opening in the abactinal pole of the specimens. No details of

[1] A. Agassiz, 1876, Proc. Am. Acad., p. 231.

the nature of this cavity having been as yet published, it is not possible to compare the two modes of carrying the young in these two genera more closely.

"In Spatangoids, with deeply sunken ambulacra, we find, nearly in all cases, that from the sharp edge of the ambulacral groove, long spines extend, so as nearly to close the opening of the cavity, entirely bridging it over, and completely concealing from view the ambulacral pores. This arrangement has usually been considered in Spatangoids as a sort of filter to keep foreign particles from affecting the delicate water tubes, which in the Spatangoids perform more or less the function of gills. This is undoubtedly the case in several genera, but in the case of *Hemiaster*, and perhaps in other allied genera, the sunken ambulacral area is used for an entirely different purpose, as was correctly observed by Philippi—that of sheltering the young.

"That the many specimens (eight) found in the two posterior sunken ambulacral areas are really the young of *Hemiaster*, is, of course, only probable, from the fact that the genital openings, which are unusually large, open directly into the upper part of their sunken area; so that the eggs (or more properly an imperfectly developed pluteus, like that of *Echinaster*) on escaping from the genital openings would readily find their way into the artificial cavity formed by the spines which conceal the presence of the sunken areas.

"Unlike many Echinids, the ovaries of this genus are small, consisting of compact grape-like clusters of eggs, in very different stages of development, a few of the eggs only attaining a considerable size (nearly 1 mm.), and apparently ready to escape into the sunken area as soon as the place should be left unoccupied by the preceding brood. No two of the small Echinids were in the same stage of development; they varied in size from 2 mm. to 3 mm., the smaller specimens having a somewhat pentagonal outline, with rounded angles; the larger were more nearly elliptical and cylindrical in shape. In the smaller specimens (Pl. XX.[a] fig. 7) the spines were short, straight; the longest, and only a few in each interambulacral area, about one-fifth the length of the axis, while the greater number were mere tubercles, scarcely rising above the level of the test. In the largest specimens (Pl. XX.[a] fig. 6) many of the spines, nearly equalling the radius of the test, had become curved and had assumed the characteristic appearance of Spatangoid spines. Seen from below (Pl. XX.[a] fig. 10) the large angular mouth, covered by a thick membrane, was nearly central, somewhat anterior, the edge of the mouth on the level of the test, and a few small indistinct pores arranged in parallel lines, showing the position of the future actinal petal; the ambulacral areas were occupied by coarse granulation, while the tubercles of the interambulacral spaces were large with well-developed crenulation, and already perforated. The interambulacral areas were already broad, leaving but narrow ambulacral spaces, in which the short, club-shaped ambulacral tubes could wh difficulty be traced; they were largest near the apex, and near the actinostome. Seen from above (Pl. XX.[a] fig. 9), the most marked feature of all these young Echinids was the broad fasciole, occupying so large a part of the abactinal surface, the position of

the interambulacral area being clearly marked by the two large tubercles at the extremity of these areas on the abactinal edge of the fasciole. The whole fasciole was covered by a coarse granulation. The most striking feature in the structure of these small Echinids is the position of the anal opening (Pl. XX.[a] fig. 9). This is nearly in the central part of the abactinal surface towards the posterior edge, and entirely surrounded by the fasciole. This fasciole, from its position, must undoubtedly be the peripetalous fasciole, as it agrees in position with the same fasciole in *Brissopsis*, though in the latter genus it does not enclose the anal opening. In the adult *Hemiaster* the anal opening is not thus surrounded, an additional example of the little value we can place upon the position of the anal opening as a systematic character. The transfer of the anal opening to the exterior of the fasciole I was not able to trace, all the specimens being too young to show when it took place. There is no trace in these young stages of any genital openings, or of genital plates; the ocular plates are somewhat more prominent than the other ambulacral plates, one especially, that of the odd ambulacrum (see Pl. XX.[a] fig. 9). On opening one of these young Echinids (Pl. XX.[a] fig. 11) we find that, notwithstanding the position of the anal opening, the intestine already makes a half circuit round the edge of the test, and is attached to the sides by the usual mesenteries, the actinal extremity of the alimentary canal towards the anterior end being free; the stone canal also leads nearly vertically from the anal opening to a terminal interambulacral plate situated to the right of the odd ambulacrum. The anal opening is large, pentagonal, separating completely the trivium from the bivium, and is covered by a large plate having a small opening opposite the left posterior ambulacrum.

"The only other young Spatangoid known, resembling so closely a regular *Echinus*, is a young Spatangoid figured by Müller, while still in the pluteus stage, with straight spines similar to these figured here in the youngest specimen. This was the first indication we had of the great similarity of the spines of the young stages in the regular and irregular Echinids. The presence of an anal opening in the young *Hemiaster* connected, so to speak, with the abactinal system, is a most interesting feature, as well as the complete separation of the bivium and trivium, the origin of which among Echinids had not been understood. The whole family of Collyritidæ, in which this is the normal state, appear in geological times as an abnormal group, disconnected entirely, and isolated from all the other Spatangoids, which it precedes in time, and seeming thus far to have no connection with the Spatangoids of later geological periods. Their connection as an embryonic stage is now clearly shown by the young of *Hemiaster*, here figured, as well as the close relationship existing between the regular Echinids and such Spatangoids as *Collyrites*, appearing as the earliest geological representatives of the Spatangoids. The Collyritidæ are, therefore, not structurally so far removed as has been generally supposed from the regular Echinoidea.

"The earlier development, that preceding the stage when the embryo escapes into

the ambulacral area, could, of course, not be traced satisfactorily. But enough could be seen of the shape of the embryo mass to render it highly probable that the development was very similar to that of other viviparous Echinoderms (Star-fish and Ophiurans), in which the young are carried about by the parents till they are well advanced Star-fishes (Sars, Müller, Agassiz), or hatched from the main cavity as well-developed Ophiuridæ (Quatrefages, Schultze, Lyman, Agassiz), and where the plutean development is passed through in a very imperfect manner, owing to the rudimentary development of the arms, which take such an extreme degree of growth in the pelagic pluteus of Echinids and Ophiurans, traces only of these arms being found in the younger stages of growth of these viviparous Echinoderms.

"The specimens I have had the opportunity of examining were collected at Kerguelen Island by Dr J. H. Kidder, the naturalist attached to the Transit of Venus expedition, and were sent to me for examination by Professor Verrill. He has described the species as new, under the name of *Hemiaster cordatus;* but I cannot distinguish it from *Hemiaster cavernosus* and *Hemiaster australis,* which I was led to consider (from analogy with *Hemiaster philippii*) to be identical species. It is remarkable that, in the young stages of both these species, all the ambulacra are but little sunken, and it is only when they have attained a considerable size that the posterior ones begin to deepen. Philippi considered that this might be a sexual feature. We have not sufficient data to decide the question, but can only say that up to a certain size, at any rate, there is no difference in the depth of the ambulacra of males and females. (See pl. iv. figs. 4–8, Echini of "Hassler" Expedition, Ill. Cat. Mus. Comp. Zool., No. 8). I have examined a large number of a common Spatangoid from our southern coasts (*Moira atropos*), with ambulacra still more deeply sunken than in *Hemiaster*, in hopes of finding the young, but thus far without success; from the eggs of *Schizaster canaliferus* from the Mediterranean, in which some of the ambulacra are also deeply sunken, a pelagic pluteus is known to be developed; so that in many of the genera with sunken ambulacral petals the sunken area does not shelter the young in their earliest stages of development."

Among the large number of specimens of this species collected by the Challenger there were a few small specimens intermediate between the younger stages which I described in the Proceedings of the Am. Acad. from specimens collected by Dr J. H. Kidder, U.S.N., and those which were figured on plate iv. of the "Hassler" Echini in Mem. of Museum Comp. Zoology. These figures I have reproduced (Pl. XX.[a] figs. 13–17), although they do not quite fill the gap existing between the stage of Plate XX.[a] fig. 9 and Pl. XX.[a] fig. 18, which were known before, still they leave but little to trace in the history of the development of the petals, and of the gradual passage of the anal system from the abactinal surface to the posterior edge of the test, and they also show the passage of the peripetalous fasciole from that figured in stage 13 until it has assumed approximately the shape of the adult (Pl. XX.[a] fig. 18). The development of the males and females is identical to that point,

and it is only later that the differences in the depth and width of the petals becomes apparent, as I have shown in the figures of *Hemiaster* on plate iv. of the "Hassler" Echini.[1]

"The figures given on plate iv. figs. 4–8, are all natural size, and show the changes the lateral ambulacra undergo as they pass from fig. 8 to fig. 7, and from fig. 6 to fig. 4. When the specimens reach the size of fig. 7, the change from comparatively shallow lateral ambulacra to the deep ambulacra of fig. 6 takes place without a great increase in the size of the test. The anterior ambulacra, eventually the most concave (fig. 4), are the first to show marked signs of depressions, and in slightly older specimens than figs. 7 or 6 they are already deeply sunken, while the posterior lateral ambulacra are comparatively shallow. In most of the specimens examined I have found large globular, short-stemmed pedicellariæ situated in the sunken ambulacral petals, usually the anterior pair, as mentioned by Philippi. Owing to the comparatively long spines of the edge of the petals, the sunken ambulacra are completely hidden by a screen of spines. The changes of outline of the test are very limited after the specimens have attained the size figured on plate iv. fig. 8. The outline of the test is somewhat more angular and gibbous, seen from above, and perhaps less conical and somewhat more flattened at the apical system. The number of genital pores is variable, as we find two or three quite indifferently; the posterior pair of genital openings is always present, if a third exists it is the right anterior one usually, but sometimes the left. In the youngest specimen figured the outline of the peripetalous fasciole is nearly the same as in the oldest specimen examined (fig. 4), though its breadth becomes greater with advancing age. The odd anterior ambulacrum increases but little in depth and breath with increasing size."

In the magnified views of the apical system of a male (Pl. XX.[a] fig. 21) and of a female (Pl. XX.[a] fig. 22), the difference between the size of the genital openings is very striking, as well as the sudden sinking of the floor of the apical extremity of the paired ambulacra in the female to form the marsupial pouches. The genital openings are developed comparatively late, there is no trace of them until they attain the size figured on Plate XX.[a] fig. 15. In one female (Pl. XX.[a] fig. 19) there were only two genital openings, and it was the left anterior which disappeared next, leaving the two posterior genital openings.

Professor A. E. Verrill has carefully described the differences existing between the males and females of specimens collected at Kerguelen Island by Dr J. H. Kidder (Bull. U. S. Nat. Museum, No. 3). These specimens he described under the name of *Hemiaster cordatus* (Bull. U. S. Nat. Mus., 1876, No. 3, p. 69), as he, not having a sufficient series of the South American species (*Hemiaster cavernosus* and *Hemiaster australis*) for comparison, preferred to regard it for the present as distinct. The specimens he sent me at the time for comparison I could not distinguish from the South American species. The Challenger series is so extensive, and shows such a range of variation

[1] A. Agassiz, 1874, Zool. Results of the "Hassler" Expedition, Ill. Cat. Mus. Comp. Zool., No. 8.

both in form and in the structure of the petals according to age and sex, that I am quite convinced it is impossible to define the Kerguelen specimens as a different species. One of the specimens from Station 310 combines the features of the two sexes in having nearly flush posterior ambulacral petals, while the anterior petals are almost as deeply sunken as in well-developed females of the same size.

Dr Studer also collected *Hemiaster cordatus*, Verrill, at Kerguelen Island, and enumerates it as a distinct species in his list of Kerguelen Echinoderms (Berlin Akad. Monatsb., July 1876, p. 457). He also speaks of finding the young in the cavity of the external pouches of the petals of the large females. Mr Edgar Smith has also noted this species in the Echinodermata of Kerguelen Island (Trans. Roy. Soc., 1879, vol. clxviii. p. 272).

From the evidence furnished by the large material collected by the Challenger, there seems but little doubt the species which have thus far been distinguished as *Hemiaster australis*, *Hemiaster philippii*, and *Hemiaster cavernosus* are all different stages of growth of one and the same species, but owing to the great difference in structure between the ambulacral petals of the males and females, and the extraordinary changes this species passes through from its youngest stage until it has reached its adult sexual form, it was very natural that these several stages of growth should on scanty material have been regarded as so many distinct species.

The coloration of specimens from different localities appears also quite distinct, and in some cases the test and spines are of a light brownish-yellow, in striking contrast to the dark-coloured specimens found at other localities.

Station 151. February 7, 1874. Off Heard Island. 75 fathoms; mud.

Station 310. January 10, 1876. Lat. 51° 30′ S., long. 74° 3′ W.; 400 fathoms; bottom temperature, 7·9° C.; mud.

Kerguelen Island, Betsy Cove. 15, 25 and 250 fathoms.

Kerguelen Island. 10 to 100 fathoms.

**Hemiaster gibbosus* (Pl. XX. figs. 5, 16, 22; Pl. XXXIX. fig. 16).

Hemiaster gibbosus, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 210.

This is quite a large species, measuring 30 mm. in length. The outline seen from above is variable, in one case (Pl. XX. fig. 5) it was nearly elliptical; in another specimen of about the same size, the posterior extremity was much the widest (Pl. XX. fig. 6). Seen in profile the test is vertically truncated at the posterior extremity, the apex is close to the posterior edge, thence the test slopes gradually towards the anterior, somewhat beyond the apical system. The anterior extremity is also abruptly truncated and rounded towards the flat actinal surface. The posterior extremity of the actinal surface forms a rounded keel, as is seen from the anal extremity (Pl. XX. fig. 8). The outline seen facing the anterior extremity is nearly globular. The small anal system is placed high upon the

posterior extremity of the test in a shallow groove; the test is covered with tubercles of uniform size equally distributed over the plates (Pl. XX. figs. 5, 8), except in the lateral posterior interambulacra, where the plates are comparatively bare (Pl. XX. fig. 7), as well as on the actinal surface (Pl. XX. fig. 6), where the tubercles are somewhat larger in the interambulacral areas and on the actinal plastron. The peripetalous fasciole is broad, pentagonal, with rounded corners; the anterior lateral ambulacra are longer than the posterior pair, the latter being comparatively short. The petals are all slightly sunken, the odd ambulacral petal is the longest, and its pores are double but not conjugate (Pl. XX. fig. 9).

In the apical system there are four large genital plates; the right anterior carries the madreporic body (Pl. XX. fig. 11); the bivium is separated from the trivium by two large intercalated interambulacral plates. The actinostome is placed in a slight depression formed by the sloping in of the last actinal plates of the trivium and adjoining lateral posterior interambulacra. The posterior interambulacral labium is prominent (Pl. XX. fig. 6); the actinostome is narrow, transverse, the buccal shields extending from the anterior edge occupy the greater part of the opening. The lateral petaloid ambulacra have broad, flat, triangular feet, with rounded tips (Pl. XX. fig. 22), while the suckers of the odd ambulacrum and the other ambulacra outside of the petals have simple feet with indistinct suckers. The spines are long, cylindrical at the base, and slightly club-shaped at the extremity (Pl. XX. fig 12); from the ambitus to the actinostome they are larger, longer, and pointed, the spines of the actinal plastron are specially prominent diverging from the median line; they are spathiform and quite stout. The miliaries are short club-shaped spines (Pl. XX. figs. 12, 14, 15) similiar to those of the fascioles, only stouter, showing as plainly as possible that the spines of the fascioles are only minute miliary spines arranged in definite rows. I cannot understand why writers on Echinoderms insist continually in bringing up the relationship of the fascioles and of the vibratile chords of the Pluteus and Brachiolarians. To any one who has studied the embryology of Echinoderms, and has followed the homology of the spines, this appears utterly unmeaning. What possible relation there can be between a chord of vibratile cilia such as we find fringing certain plastrons of the Pluteus and the specialisation of calcareous spines remaining in a more or less embryonic stage, and arranged along certain lines which only appear after the young Sea-urchin has reached a considerable degree of development, I am unable to perceive. The intermiliary granulation (Pl. XX. fig. 13) reminds us of the intermiliary granulation of such genera as *Arbacia*, in which these granules are isolated and pass by degrees into club-shaped spines recalling the miliary spines of this species.

The suckers of the petaloid ambulacra are interesting for their close affinity to the suckers of the petaloid area of *Echinarachnius*, which form, as it were, the natural link between the fringed suckers of the petaloid ambulacra of the higher Spatangoids through

such forms as those of *Hemiaster gibbosus* here figured and those of the ordinary Desmosticha consisting of a simple tube with a terminal sucker (see Revis. Echini., pl. xxxi. figs. 4–9).

Station 191. September 23, 1874. Lat. 5° 41′ S., long. 134° 4′ E.; 800 fathoms; bottom temperature, 3·9° C.; mud.

Station 232. May 12, 1875. Lat. 35° 11′ N., long. 139° 28′ E.; 345 fathoms; bottom temperature, 5·0° C.; sandy mud.

**Hemiaster zonatus* (Pl. XX. figs. 1–4).

Hemiaster zonatus, Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 212.

Lovén has figured in his Études sur les Echinoïdées, pl. xi. figs. 93, 94, a young *Hemiaster* (*H. expergitus*) collected by the "Eugenia" near the Azores at a depth of 600 fathoms. The Challenger also dredged near the same locality specimens of a *Hemiaster* which I cannot refer to Lovén's species at present, although the differences between them are such that they may only be due to age.

This species differs from *Hemiaster gibbosus* in having a deeper anal groove, a broader and more eliptical peripetalous fasciole, and coarser spines more evenly distributed over the whole of the abactinal surface.

The outline of this species is also more globular, and it evidently has its nearest ally in the characteristic Cretaceous *Hemiaster prunella.*

Station 126. September 12, 1873. Lat. 10° 46′ S., long. 36° 8′ W.; 750 fathoms; mud.

Station 8. February 12, 1873. Off Gomera, Canaries; 620 fathoms; sandy mud and shells.

Rhinobrissus (*Hemiaster*).

Rhinobrissus, A. Agassiz, 1872, Bull. Mus. Comp. Zool., vol. iii.

**Rhinobrissus hemiasteroides* (Pl. XXXV.[b] figs. 12–15).

Rhinobrissus hemiasteroides, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 211.

We find in this species a combination of some of the features of *Rhinobrissus* with characters of *Metalia*, *Brissopsis*, *Hemiaster*, and *Brissus.* It has the peripetalous fasciole of the former, and the anal fasciole of the latter genera, the deeply sunken petals of *Hemiaster* combined with the flush odd anterior ambulacrum and the remarkably broad actinal ambulacral areas round the actinostome of *Rhinobrissus.*

At first glance when covered with spines, this species would readily be taken for a young specimen of *Metalia sternalis*, but it has, unlike this species, no anterior ambulacral groove. The anterior ambulacrum is flush with the test which forms a slight keel in the median anterior ambulacral area (Pl. XXXV.[b] figs. 12, 13). The peripetalous fasciole is

as in *Metalia* moderately broad, but scarcely more indented than in *Brissopsis* and *Hemiaster*. It has, like *Brissopsis*, an anal fasciole, and a closed subanal fasciole independent of it (Pl. XXXV.[b] fig. 15). The actinal plastron is very elongated, narrow, extending from the diamond-shaped subanal fasciole nearly to the actinostome (Pl. XXXV.[b] fig. 14). The actinostome is broadly transverse, the ambulacral areas broad, carrying large tufted ambulacral tubes to the edge of the ambitus. The spines of the abactinal surface do not differ in their general aspect from those of *Metalia sternalis*. The paired ambulacral petals are sunken much as in *Hemiaster* (Pl. XXXV.[b] fig. 12), the anterior pair are widely separated, placed at right angles to the longitudinal axis; the posterior pair make but a slight angle with it, are less sunken and are separated by a well-defined rounded ridge. There are four genital pores placed close together. This species seems to be intermediate between *Brissus* proper and the species which have been separated from it, as *Metalia* (*M. sternalis*) and the like. The apex corresponds as in *Metalia* with the abactinal system (Pl. XXXV.[b] fig. 13), and is placed nearer the anterior extremity, while it is posterior in *Rhinobrissus*.

The only specimens thus far collected show that this species is smaller than *Rhinobrissus pyramidalis*; the spines of the abactinal surface are short, of uniform size; on the actinal side in the lateral posterior ambulacra they are remarkably long, their colour in alcohol is whitish.

Papeete Harbour, Tahiti; 20 fathoms. September 28, 1875.

**Cionobrissus.*

Cionobrissus, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 206.

This genus is specially interesting, forming as it does a transition between the Brissina and the Pourtalesiæ. It has the facies of the former (Pl. XXIII. fig. 1), resembling such forms as *Brissopsis*, but having retained somewhat the cylindrical form of the Pourtalesiæ, and also possessing a rudimentry anal snout (Pl. XXIII. figs. 1, 4, 7) immediately below the anal system, so characteristic of the latter family, and of which the beak of the subanal plastron in *Echinocardium* and the like is perhaps the first trace, or of which the well-defined area enclosed by the subanal fasciole is the first rudiment, and which in the Pourtalesiæ takes so extraordinary a development as an anal snout. This characteristic feature of the Pourtalesiæ of a subanal fasciole running round the base of the anal snout (Pl. XXIII. fig. 7) is combined in *Cionobrissus* with a peripetalous fasciole of the Brissina (Pl. XXIII. figs. 1, 6), and ambulacral petals recalling those of *Macropneustes* from the presence of large primary ambulacral tubercles in the interambulacral areas (Pl. XXIII. fig. 6) within the peripetalous fasciole. The groove of the anterior ambulacrum extends to the actinostome (Pl. XXIII. fig. 9), but is far less marked than in the Pourtalesiæ, and the actinal surface is not flattened but arched (Pl. XXIII. figs. 4, 5), as is

generally the case in that family, the actinal keel forming a prominent rounded keel extending from the actinostome to the extremity of the anal snout (Pl. XXIII. figs. 1, 4, 5, 7).

**Cionobrissus revinctus* (Pls. XXIII., XXXV.[b] fig. 18 ; Pl. XXXIX. fig. 22 ; Pl. XLI. figs. 41–43).

Cionobrissus revinctus, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 206.

The test of this species is ovoid (Pl. XXIII. figs. 1–5), with a moderately sunken anterior ambulacrum (Pl. XXIII. figs. 3, 5, 6, 9); this is flush with the test near the apical system, deepest at the ambitus (Pl. XXXV. fig. 18), and extends to the actinostome. The actinostome is anterior to the centre (Pl. XXXIII. fig. 3; the actinal plastron is strongly arched, very prominently defined near the posterior extremity of the actinal surface, where it forms a rounded keel (Pl. XXIII. figs. 1, 7) immediately below the anal snout; this plastron is closely packed with tubercles, diminishing in compactness towards the prominent posterior lip of the actinostome (Pl. XXIII. figs. 1, 9).

Immediately round the actinostome on each side of the actinal plastron the ambulacral areas are broad and bare (Pl. XXIII. fig. 9); the tubercles of the actinal surface are largest next to the ambulacral area, and in the interambulacral zones; they diminish very gradually in size towards the ambitus (Pl. XXIII. fig. 1) and thence again to the peripetalous fasciole. The tubercles are quite uniformly placed on the whole test (Pl. XXIII. figs. 1, 4, 5) with the exception of the space within the peripetalous fasciole, where the primary tubercles of the interambulacral area greatly increase in size (Pl. XXIII. fig. 6), carrying comparatively long curved spines which completely hide the petals (Pl. XXIII. fig. 2); the spines on the actinal surface are similar to those of the primary tubercles within the fasciole but smaller (Pl. XXIII. fig. 3), while the rest of the test is thickly covered by shorter curved spines (Pl. XXIII. figs. 2, 3). In alcohol the test is of a dirty olive colour, with lighter coloured spines.

The peripetalous fasciole is narrow (Pl. XXIII. fig 6), and with the exception of the re-entering angle it makes before crossing the odd anterior ambulacrum (Pl. XXIII. fig. 5 ; Pl. XXXV.[b] fig. 18) runs almost an elliptical course round the tips of the petals. The anterior pair of petals are somewhat shorter than the posterior pair (Pl. XXIII. fig. 6), the ambulacral plates being more crowded together; the exterior pore in the paired petals is far larger than the interior one (Pl. XXIII. fig. 6).

The subanal fasciole is broad, vertically elliptical, pointed towards the actinal plastron (Pl. XXIII. figs. 1, 4, 7). The anal system is small, circular (Pl. XXIII. fig. 4), placed well up near the abactinal surface. The structural apex is anterior. There are four genital pores (Pl. XXIII. fig. 6) enclosing a madreporic body, which extends into the odd posterior interambulacral space.

Seen in profile the test is abruptly rounded from the actinostome; at the anterior

extremity it runs slightly arching to the apex, where it suddenly drops again to the anal snout, which extends beyond the general outline, forming a sharp beak with the convex curve extending from the actinostome to the abactinal edge of the anal snout. The spines within the subanal fasciole form a prominent tuft, as they are somewhat more closely packed than on the rest of the test (Pl. XXIII. fig. 2). The arrangement of the large tubercles within the peripetalous fasciole in this genus is not like that of *Macropneustes*, but it closely resembles that of some species of *Metalia*, and in that genus we find a very marked tendency to form a subanal beak in the area limited by the very prominent subanal fasciole. In *Brissopsis* this snout or beak, as well as the development of the primary tubercles, is reduced to a minimum, while the genus (*Brissopsis*) still retains the more cylindrical outline and the sunken anterior ambulacrum of *Cionobrissus;* while in some species of *Metalia* with the other features are associated a flattened actinal surface as in *Spatangus* proper.

Station 191. September 23, 1874. Lat. 5° 41′ S., long. 134° 4′ E.; 800 fathoms; bottom temperature, 3·9° C.; mud.

Brissopsis (*Hemiaster*).

Brissopsis, Agassiz, 1840, Cat. Syst. Ectyp., p. 16.

Brissopsis luzonica.

Kleinia luzonica, Gray, 1851, Ann. Mag. Nat. Hist., vol. vii. p. 133.
Brissopsis luzonica, A. Agassiz, 1872, Revis. Ech., part 1, p. 95.

De Loriol has also united, as I have done, *Toxobrissus* (*Kleinia* of Gray) with *Brissopsis*. Lovén, however, still retains *Kleinia* on account of the slender connection of the peripetalous and of the subanal fasciole; this, as I have shown elsewhere, does not seem to be of generic value.

Station 168, July 8, 1874. Lat. 40° 28′ S., long. 177° 43′ E.; 1100 fathoms; bottom temperature, 2·0° C.; grey ooze.

Station 188. September 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E.; 28 fathoms; mud.

Station 191. September 23, 1874. Lat. 5° 41′ S., long. 134° 4′ E.; 800 fathoms; bottom temperature, 3·9° C.; mud.

Station 203. October 31, 1874. Lat. 11° 7′ N., long. 123° 7′ E.; 12 to 20 fathoms; mud.

Station 232. May 12, 1875. Lat 35° 11′ N., long. 139° 28′ E.; 345 fathoms; bottom temperature, 5·0° C.; sandy mud.

Brissopsis lyrifera.

Brissus lyrifer, Forbes, 1841, Brit. Starf., p. 187.
Brissopsis lyrifera, Agassiz, Des., 1847, C. R. Ann. Sc. Nat., vol. viii. p. 15.

I am unable to distinguish specimens of this genus collected at Station 142 from

Brissopsis lyrifera except by such indifferent characters as a somewhat more compact test with a slight keel from the apex to the anal system, a closer tuberculation, and a slightly sharper peripetalous fasciole; characters which are found in specimens coming from such distant localities as the coast of Norway and the western shore of Spain. The great bathymetrical and geographical range of this species has already been noticed.

Station 141. December 17, 1873. Lat. 34° 41′ S., long. 18° 36′ E.; 98 fathoms; bottom temperature, 9·7° C.; sand and gravel.

Station 142. December 18, 1873. Lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms; bottom temperature, 8·3° C.; sand.

Simon's Bay; 5 to 18 fathoms. Agulhas Bank; 150 fathoms.

**Aërope.*

Aërope, Wy. Thomson, Proc. Roy. Soc., vol. xxv. p. 211.

The genera *Aërope* and *Aceste*, first described by Thomson in the Voyage of the Challenger (vol. ii. p. 28, fig. 99, and p. 376, figs. 95, 96), are interesting as showing the passage of the *Pourtalesia* group to the Brissina among the Spatangoids, and the affinities of those genera to such forms as *Cionobrissus*, *Brissopsis*, and the Schizasteridæ; while having a simple circular actinostome, they have already a well-developed actinal plastron and rudimentary petals at the abactinal extremity of the lateral ambulacra, while the odd anterior ambulacral petal takes in *Aceste* an extraordinary development, and forms on the abactinal surface of the test a long broad sunken petaloid ambulacrum (as deeply sunken as in *Schizaster*) occupying nearly the whole of the abactinal surface. The peripetalous fasciole is quite similar in shape to that of young specimens of *Brissopsis* and *Hemiaster*, in which the petals are also reduced much to the same condition as we find them in these genera, simply double rows of pores on each side of the median line within the rudimentary peripetalous fasciole; one of these genera, *Aërope*, retaining something of the cylindrical shape of the Pourtalesiæ. On the other hand the Pourtalesiæ, through such genera as *Palæotropus*, *Genicopatagus*, and *Homolampas*, pass to the Spatangina, and through such types as *Urechinus* and *Cystechinus* to the Galeritidæ and Echinolampadæ.

The striking resemblance of the young *Brissopsis* with its gigantic suckers in the odd anterior ambulacrum (figured on plate xix. figs. 1, 2 of the Revision of the Echini) to the full-grown *Aërope*, plainly shows the Brissoid affinities of the genus.

The deeply-sunken odd anterior ambulacrum of *Aceste* shows the relationship of the genus to *Schizaster*, of which it also has to a certain extent the outline when seen in profile, without having any trace, however, of the petaloid lateral ambulacra of that genus; the only ambulacrum with double pores being the odd anterior one. The other ambulacra within the peripetalous fasciole have only simple ambulacral pores, as we find in *Echinocardium*, *Breynia*, and *Lovenia*, within the internal fasciole. The course of the

fasciole in *Aceste* is strikingly like that of the peripetalous fasciole of *Schizaster*, and it is indeed difficult in this genus to know whether to call it a peripetalous or an internal fasciole. Taken in connection with the course of the fasciole of *Aërope* and of *Gualteria*, in which we find the lateral ambulacra with double pores are not in the least modified within the fasciole, we cannot resist the conclusion that the internal fasciole is after all only a modification of the peripetalous fasciole; what has been called an internal fasciole is in reality only an embryonic peripetalous fasciole. If we compare the internal fasciole of *Echinocardium* with the peripetalous fasciole of a young *Brissopsis*, we shall find that it encloses mainly the abactinal region of the odd ambulacral petal, and, extending only slightly beyond the apical system, encloses only one or two pairs at the outside of the ambulacral pores of the other ambulacra, and that it is not only with increasing age that the posterior part of the fasciole extends further down on the sides of the test so as eventually to enclose the whole of the petaloid portion of the ambulacra (the abactinal portion). In *Echinocardium* and other genera in which the peripetalous fasciole always remains internal, it merely does not enclose the whole of the petaloid part of the ambulacra, and the posterior part of the fasciole remains always in close proximity to the apical system; the same is also the case in *Breynia* and *Lovenia*. In the former genus there is, however, in addition what has always been called a peripetalous fasciole. I am inclined to look upon this fasciole as a modified lateral fasciole, which takes its origin from the odd anterior ambulacral region instead of starting, as is the case in *Schizaster* and other genera, from the peripetalous fasciole in the posterior interambulacral species. I am led to take this view from a comparison of the genera in which this so-called internal fasciole exists for the following reasons:—

We find in *Lovenia* that the anterior extremity of the fasciole where it crosses the ambulacral region is nearly lost in the midst of the minute miliaries which cover the whole of the shallow anterior groove, and which it is difficult to distinguish from the miliaries of the fasciole, the whole anterior groove becoming, as it were, a broad fasciole from which the peripetalous fasciole of *Breynia*, where we find the same structural features, takes its origin, and to all appearances looks like a peripetalous fasciole, but is in reality, as is shown by *Lovenia*, a lateral fasciole, taking its origin from the anterior interambulacral region. In *Lovenia* this lateral fasciole has more the character of a marginal fasciole, extending but little beyond the anterior pair of ambulacral petals. This rudimentary fasciole in *Lovenia* is interesting as showing how easily it may be for closely allied genera to have what may seem a marginal fasciole, formed by the concentration at the ambitus of the miliary tubercles, especially if flanked above and below by coarser tubercles; in fact, the whole anterior part of the test of *Lovenia* may be said to a certain extent to be covered by a gigantic fasciole, highly specialised in a part of the test to form an internal fasciole, and a short rudimentary marginal or lateral fasciole extending a short distance along the ambitus; while in *Breynia* the structure of the anterior part of the test

is not so well marked, the lateral fasciole on the contrary is better defined, and its connection with the so-called internal fasciole more distinct, thus giving rise to the simultaneous existence of an internal and a peripetalous fasciole.

With the above limitations the peripetalous fasciole appears in all recent Spatangoids to modify the structure of the apical portion of the lateral ambulacra. This, as has been shown, is only true to a limited extent of the genera allied to *Echinocardium*. In some species of *Schizaster* the petals lose much of the prominence they have in such species as *Schizaster canaliferus* and the like, while the occurrence of such a genus as *Aceste*, in which the lateral ambulacra are not affected by the crossing of the peripetalous fasciole, and in which the abactinal part of the lateral ambulacra retains simple pores, as in the Pourtalesiæ, goes far to show what the true nature of the internal fasciole really is.

In *Aërope* the peripetalous fasciole descends below the ambitus, and affects the structure of the apical part of the ambulacra. The ambulacral pores are all double, as is the odd ambulacrum of *Aceste*, but show no trace whatever of a petaloid structure; they retain their Holasteroid features, if we may so call the straight rows of double pores of the ambulacral zones of some Spatangoids.

The genus *Gualteria* of the Nummulite of France is the oldest of the fossil genera in which we find the peripetalous fasciole extending across the petals so as to become what has been called an internal fasciole. As in *Aceste* it does not affect sensibly the structure of the petals. This fasciole holds an intermediate position between the true peripetalous fasciole placed entirely outside the petals and a normal internal fasciole, plainly showing that it is impossible to draw the line between these two kinds of fascioles. In the Revision of the Echini (pl. xiv. figs. 9, 11, 12), I have figured a young Spatangoid referred with great doubt to *Agassizia*, in which this Gualterian feature of the internal peripetalous fasciole is very marked, and in which we have a lateral fasciole starting directly from an internal fasciole in an anterior interambulacral area just as it would start from a true peripetalous fasciole.

**Aërope rostrata* (Pls. XXXIII., XXXIII.[a] figs. 8–12; Pl. XXXIX. fig. 23; Pl. XLI. figs. 7, 8).

Aërope rostrata, Wy. Thomson, Proc. Roy. Soc., vol. xxv. p. 211; Voyage of the Challenger, Atlantic, vol. i. p. 381, fig. 99.

Of this species specimens of two very different sizes were collected (Pl. XXIII. figs. 1–5 and 8–12); they differed considerably, in outline especially, when seen in profile, but I am not inclined to consider them as distinct species. The large specimen measuring 43 mm. in length was unfortunately so badly broken that it was impossible to examine its structural features without danger of completely destroying it in the preparation of either the actinal, anal, or apical system. I have, therefore, limited myself to the

detailed examination of the smaller specimens for those more important regions, and have added such structural features from the larger specimen as could be detected without injuring it.

The test of the larger specimen is comparatively stout; the abactinal region is covered posteriorly to the peripetalous fasciole with slender slightly club-shaped spines of uniform length (Pl. XXXIII. fig. 1); within the peripetalous fasciole the spines are longer, not club-shaped, somewhat more slender, and less crowded together (Pl. XXXIII. figs. 1, 3). Towards the ambitus the spines are somewhat more crowded (Pl. XXXIII. fig. 3), and on the actinal side they are club-shaped, longer, stouter, and closely packed round the exterior half of the actinal region (Pl. XXXIII. fig. 2). The median space is left quite bare towards the small actinal plastron and round the actinostome; the actinal plastron carries a small number of large spathiform curved spines.

The test is quite cylindrical (Pl. XXXIII. figs. 5, 5′), and the anal system (Pl. XXXIII. figs. 1, 5, 7) is placed well up on the abactinal surface. Seen in profile (Pl. XXXIII. fig. 3), the anterior part of the test is abruptly rounded, curving more gradually towards the apex, which is posterior to the apical system and placed somewhat anteriorly immediately beyond the broad peripetalous fasciole (Pl. XXXIII. figs. 3, 5′); it then curves more gradually towards the posterior extremity which is pointed.

Seen from above, the outline is rounded anteriorly (Pl. XXXIII. figs. 1, 2), with a slight re-entering angle at the odd median ambulacral area. Even in this largest specimen the gigantic ambulacral suckers (Pl. XXXIII. fig. 1) of the odd anterior ambulacrum, usually characteristic in Spatangoids of the younger stages only, are fully as prominent as in the smaller specimen (Pl. XXXIII. figs. 8, 10). There are eight of these gigantic ambulacral feet surmounted with huge sucking disks (Pl. XXXIII. figs. 1, 5′, 6, 8, 10); through the genital openings pass four long slender pointed tubes (Pl. XXXIII. figs. 5, 6, 8). These large ambulacral feet are placed on each side of a broad median ambulacral zone (Pl. XXXIII. figs. 5, 6, 8); the principal peripetalous fasciole is very broad near the apex, rounded posteriorly (Pl. XXXIII. fig. 1), and gradually slopes towards the ambitus on the anterior part of the test (Pl. XXXIII. fig. 3; Pl. XXXIII.[a] fig. 9). The actinostome is circular, placed in advance of the centre (Pl. XXXIII. fig. 2; Pl. XXXIII.[a] figs. 8, 11), surrounded by a ring of ten large ambulacral suckers (figured by Thomson, Voyage of the Challenger, vol. i. p. 381, fig. 99). The genital organs form flattened clusters occupying the anterior abactinal part of the test (Pl. XXXIII. fig. 4). The intestinal canal runs at first towards the anal part of the test (Pl. XXXIII. fig. 4), thence it makes a complete loop to the anterior end, back again to the posterior extremity and then runs again towards the anterior edge of the test, enclosing at the posterior end the first part of the alimentary canal which starts from the actinostome. From the second anterior loop it runs to the posterior part of the test, forming a small loop again, before the small intestine finally passes to the anal opening.

The smaller specimen, measuring 20 mm. in length, is, when seen from above (Pl. XXXIII. fig. 8), less elongated posteriorly; the anterior extremity, when seen in profile, is more abruptly rounded (Pl. XXXIII. fig. 10; Pl. XXXIII.[a] fig. 9); the peripetalous fasciole is broader (Pl. XXXIII.[a] fig. 10); the posterior extremity turns upwards, and the spines covering the test are comparatively smaller and more distant; the test is also somewhat more flattened on the actinal side, as shown from the end view (Pl. XXXIII. fig. 11), and from the sloping anterior part of the test (Pl. XXXIII.[a] fig. 9).

The primary tuberculation of the actinal side (Pl. XXXIII.[a] fig. 8) is much coarser than that of the sides of the test (Pl. XXXIII.[a] fig. 9), and both in *Aërope* and *Aceste* we find the proportions between the size of the ambulacral and interambulacral coronal plates corresponding more with that of the normal Spatangina.

From the great elongation of the posterior part of the test, the lateral posterior interambulacral, and ambulacral plates near the ambitus are greatly extended. The apical system is compact, the madreporic body occupying the greater part of the inner edges of the anterior genital plates and of the eight posterior plates; the ocular plates are small, and completely disconnected by the four adjoining genital plates which occupy the structural apex.

The anal system is elliptical, slightly pointed (Pl. XXXIII.[a] fig. 12); the anal opening is surrounded by elongated mobile plates, while the rest of the anal system is covered by smaller plates of a uniform size arranged in three concentric rows. The difference of level between the actinal plastron and the anterior part of the test when seen in profile (Pl. XXXIII.[a] fig. 9) seems to be the first indication of the formation of the prominent labium of the true Spatangina. If in *Aërope* the keel of the actinal plastron (Pl. XXXIII.[a] fig. 8) was more decidedly indicated, we should have a well-marked lip changing the circular actinostome of the genus into a labiate one.

This change is well shown in *Aceste*, in which the actinostome, while practically circular (Pl. XXXIII.[a] figs. 5, 6), yet has a well-marked labiate actinostome (Pl. XXXIII.[a] figs. 2, 3), owing to the great development of the keeled actinal plastron and the projection of the last plate adjoining the actinostome beyond its general outline (Pl. XXXIII.[a] figs. 2, 3).

Station 191. September 23, 1874. Lat. 5° 41′ S.; long. 134° 4′ E.; 800 fathoms; bottom temperature, 3·9° C.; mud.

Bay of Biscay and Coast of Portugal; December 1872 and January 1873.

*Aceste.

Aceste, Wy. Thomson, 1877, The Voyage of the Challenger, Atlantic, vol. i. p. 376.

**Aceste bellidifera* (Pl. XXII. figs. 7–11 ; Pl. XXXIII.[a] figs. 1–7 ; Pl. XXXIX. fig. 21 ; Pl. XL. figs. 66–68 ; Pl. XLI. figs. 13–16 ; Pl. XLII. figs. 26–28 ; Pl. XLIII. fig. 25 ; Pl. XLIV. figs. 45, 46).

Aceste bellidifera, Wy. Thomson, 1877, The Voyage of the Challenger, Atlantic, vol. i. p. 376, figs. 95, 66.

At first glance this appears one of the most remarkable of Sea-urchins. When seen from the abactinal side (Pl. XXXII. fig. 8) nearly the whole of the abactinal surface is occupied by the deeply-sunken, broad, odd anterior ambulacrum surrounded by a narrow elongated pentagonal peripetalous fasciole, within which spring large flattened spathiform spines curving over the few huge ambulacral suckers which fill nearly the whole of the sunken space of this area. The abactinal surface is quite flattened (Pl. XXXIII.[a] figs. 4, 5), so that when seen in profile (Pl. XXXII. figs. 9–11, figs. 9, 10, 11 are figured with the actinal surface towards the upper side of the plate) the test is seen to arch regularly towards both the anterior and posterior extremities (Pl. XXXIII.[a] fig.). The apical system is placed just within the posterior edge of the peripetalous fasciole (Pl. XXXII. fig. 8), from which the test slopes rapidly towards the actinal surface. The anterior extremity is deeply indented (Pl. XXXII. figs. 7, 8, 9), the anterior part of the odd ambulacrum running in a deep groove from the abactinal region to the actinostome (Pl. XXXII. fig. 9 ; Pl. XXXIII.[a] figs. 1, 5).

The actinal plastron is large and prominent (Pl. XXXIII.[a] fig. 4) carrying long spathiform spines (Pl. XXXII. figs. 7, 9–11) ; those which cover the test are shorter and stouter (Pl. XXXII. fig. 8), while those surrounding the anal system (Pl. XXXII. figs. 7, 10) are long, curved, and pointed. The spines on each side of the actinal groove are closely crowded. Seen from the extremities (Pl. XXXII. figs. 9, 10) the test is seen to arch regularly from the actinal keel in the centre of the plastron to the ambitus, which in this genus is close to the flattened abactinal surface (Pl. XXXII. fig. 9 ; Pl. XXXIII.[a] figs. 4, 5) ; the test is somewhat more rounded toward the posterior end (Pl. XXXII. fig. 10 ; Pl. XXXIII.[a] fig. 4).

The enormous development of the suckers of the odd anterior ambulacrum is an eminently embryonic feature, it exists in the youngest stages of all the Spatangoids of which we know the development. In some species of *Schizaster* this character is also found. In *Aceste* also, as in the Schizasteridæ, we find the apical part of the anterior lateral ambulacra made up of extremely narrow plates (Pl. XXXIII.[a] figs. 1, 7), which form the thin edge of the deep anterior groove, along the sides of which extend in *Aceste* the simple anterior lateral ambulacra (Pl. XXXIII.[a] figs. 1, 7), and in *Schizaster* proper the more or less narrow anterior ambulacral petals placed within the peripetalous fasciole,

while the short posterior lateral ambulacral petals of *Schizaster* are replaced in *Aceste* by the three or four ambulacral plates perforated with simple pores, which are placed within the so-called peripetalous fasciole; this fasciole affecting in no way the structure of the ambulacral plates placed within its limits.

The general outline of the test as seen both in profile and from above is strikingly similar to that of the Schizasteridæ. In fact, this genus is of the greatest interest, showing as it does striking affinities on the one side to the Schizasteridæ and other Spatangina, such as *Brissopsis*, and on the other to the Pourtalesiæ, not only in the structure of its ambulacral system, but also from the position and shape of the actinostome, and the more or less cylindrical test modified in its outline from its Schizasterid affinities. This is well seen in the end views of the test (Pl. XXXIII.[a] figs. 4, 5), the anterior part of which is more angular, as in the Schizasteridæ, while the posterior is more cylindrical, as in the Pourtalesiæ and Brissina.

Seen from above the tuberculation of the test is quite uniform (Pl. XXXIII.[a] fig. 1), with the exception of the ambulacral zones within the fasciole, which consist of smaller tubercles. Seen from the actinal side the actinal plastron (Pl. XXXIII.[a] fig. 2) is covered by large primaries with a flat areolar space, with large primary tubercles extending over the anterior part of the test mainly in the interambulacral areas adjoining the actinostome (Pl. XXXIII.[a] figs. 3, 5). The tuberculation of the posterior part of the test is smaller, and the tubercles are more closely packed (Pl. XXXIII.[a] figs. 2, 3, 4).

The anal system (Pl. XXXIII.[a] figs. 2, 4) is placed on the steep sloping posterior extremity of the test about half-way from the level of the actinal plastron to the edge of the fasciole. It is circular, slightly pointed vertically; the anal opening is near the lower edge of the anal system. The anal system is covered with small elongated plates arranged in more or less irregular concentric rows round the anal opening. Seen from the actinal side the anal system appears on that side of the test (Pl. XXXIII.[a] fig. 2). The largest specimen collected measured 27 mm. in length, the smallest 14 mm.

In *Aceste* there are in the broad odd ambulacral field within the poriferous zone of the abactinal system a few minute spines (Pl. XL. fig. 66), which are interesting as presenting a modification of the tip of the spine not hitherto observed. It is a change from the usual flattened, paddle-shaped, or club-shaped tip characteristic of the spines of so many Spatangoids to form an umbrella-like hood. This hood is formed by a ring of large serrations projecting far beyond the general outline, and gradually passing again both above and below into the regular reticulation of the spine. The only similar structure known in spines is that of the Ophiuran genera *Ophiohelus* and *Ophiotholia*, collected by the "Challenger" and by the "Blake," where, owing to the small number of cells composing the spine, this umbrella-like structure is more apparent than it is in *Aceste*. This peculiar spine of *Aceste* is also interesting as showing a possible transition from normal to more specialised spines, which may in part perform the functions of pedicellariæ.

The pedicellariæ of *Aceste* are few in number and large; those found in the odd ambulacral area on the abactinal side belong to the large-headed type (figured on Plate XLIII. fig. 25; Pl. XLIV. fig. 46). Those of the test are somewhat larger, but differently shaped, and end in a short single-pointed blunt hook (Pl. XLIV. fig. 45).

Station 8. February 12, 1873. Off Gomera, Canaries. 620 fathoms; sandy mud and shells.

Station 272. September 8, 1875. Lat. 3° 48′ S., long. 152° 56′ W.; 2600 fathoms; bottom temperature, 1·0° C.; radiolarian ooze.

Station 323. February 28, 1876. Lat. 35° 39′ S., long. 50° 47′ W.; 1900 fathoms; bottom temperature, 0·0° C.; grey mud.

Brissus.

Brissus, Kl., 1734, Nat. Disp. Ech.

In the list of the Spatangoids of the Hamburg Museum given by Bolau, he retains the specific names adopted by Agassiz and Desor, while adopting at the same time some of the generic subdivisions lately proposed. It is evident from the contradictory views of recent writers, both in fossil and recent species, that to make a satisfactory revision of the Brissina far more material is required than at present exists in any single museum.

**Brissus damesi*, n. sp. (Pl. XXX.[a] figs. 15, 16).

It is with considerable hesitation that I refer to the genus *Brissus* small specimens collected by the Challenger at Station 75, off Fayal. The peripetalous fasciole, which in the adult specimens of the genus is so well marked, does not exist at all in a specimen measuring 9 mm. in length, while, as we know in other Spatangoids such as *Brissopsis*, it is already at a corresponding stage remarkably well developed. In a specimen measuring 23 mm. in length, this fasciole is most indistinct, and can only with difficulty be traced from its imperfectly developed and disconnected portions; but where found, they occur in the usual path of this fasciole. The subanal fasciole, on the contrary, is well developed in the larger specimen and well blocked out in the smaller one; the anal edge of the fasciole is especially broad but smaller than in *Brissopsis unicolor*. It is possible that this may prove to be the young of a Brissoid not yet described, but judging from the changes due to growth in *Metalia*, I do not venture to do anything beyond calling attention to the interesting points which the study of small specimens of *Brissus* would clear up; as it is evident that Spatangoid genera of an ovoid form with narrow ambulacral petals nearly flush with the test, and with an indistinct or no peripetalous fasciole, as in *Brissus*, and a subanal fasciole, are closely allied to *Brissus*, of which they represent the permanent embryonic state.

Compared to a specimen of *Brissus unicolor* of the same size, 23 mm., this species

is marked by the greater elongation of the posterior extremity of the test, the more vertically truncated anal end, the greater size of the anal system (Pl. XXX.[a] fig. 16), the comparatively narrower and stouter lateral ambulacral petals nearly flush with the test (Pl. XXX.[a] fig. 15), the very indistinct disconnected peripetalous fasciole, the anterior part of the test sloping towards the ambitus quite gradually, and the regularly elliptical actinal plastron; while in *Brissus unicolor* it is broadest near the subanal fasciole, the size of this fasciole is also comparatively much smaller than in the undoubted *Brissus unicolor*. The depths at which these small specimens were found seems also to indicate either a well-marked variety of *Brissus unicolor* or more probably the young of a hitherto undescribed species of *Brissus*, and it will be very interesting to see what becomes of this rudimentary peripetalous fasciole, or whether this is only an abnormal case of development, as this type of *Brissus* would if adult be closely allied to *Macropneustes* with no peripetalous fasciole, and also to *Micraster* from the slender development of its petaloid system. This species seems to hold to *Brissus* much the same relations which *Nacopatagus* holds to *Spatangus* proper.

Dames has figured as *Brissus* (comp. *B. dilatatus*, Des.) a small species, which seems in many respects to be more closely allied to this species than any other of the genus. Dames [1] gives no fascioles, and I am unable from his descriptions in the text or explanations of the plates to determine whether the peripetalous fasciole existed or not in his specimens. The general structure of the petals and of the tuberculation of that species agrees well with ours, but the shape of the actinal plastron is different.

The delicate peripetalous fasciole of a species of *Peripneustes* [2] which Dames also figures, leads me to think that Dames' *Brissus* may possibly be the young of this genus, and that the species of *Brissus* to which I have called attention is the living representative of this Tertiary *Peripneustes*, which in its turn is certainly most closely allied to the recent *Brissus*.

We have already in *Brissus damesi*, where the petals are nearly flush with the test and scarcely petaloid, a close approximation to such Tertiary forms as *Heterobrissus* of Manzoni and Mazetti, in which the petaloid extremity of the ambulacra near the abactinal pole differs from the rest of the ambulacral zone in having two pairs of pores, much as we find it in the embryonic petals of *Spatangus* and *Brissopsis*, in the younger stages of growth; this seems to be the very type of ambulacra which we find in such genera as *Pygaster* and *Pileus* and in the Galeritidæ, only limited to the abactinal region; the actinal region having already assumed the Spatangoid limitations of the simple pores which extend to their junction with these rudimentary Galeritid petals.

[1] Dames, Palæontograph. xxv., III. F. i. p. 74, pl. xi. fig. 4.

[2] Dames, *Peripneustes* does not seem to me to belong to *Peripneustes* of Cotteau, which I take to be a true *Meoma*, the species which Cotteau figures (Échinides Tert. de St Barthèlemy et Anguilla, 1875) being closely allied to the common West India species, *Meoma ventricoso*.

Station 75. July 2, 1873. Lat. 38° 37′ N., long. 28° 30′ W.; 450 fathoms; sand. Off Fayal.

Station 122. September 10, 1873. Lat. 9° 5′ S. to 9° 10′ S., long. 34° 49′ W. to 34° 53′ W.; 350 fathoms; mud.

Metalia (*Brissus*).

Plagionotus, Agassiz, 1847 (*non* Muls., 1842).
Metalia, Gray, 1855, Cat. Rec. Ech.

Metalia maculosa.

Echinus maculosus, Gmel., 1788, Linn. Syst. Nat.
Metalia maculosa, A. Agassiz, 1872, Revis. Ech., part 1, p. 144.

Station 188. Sept. 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E.; 28 fathoms; mud.

Metalia pectoralis.

Echinus grandis, Gmel., 1788, Linn. Syst. Nat.
Metalia pectoralis, A. Agassiz, 1872, Revis. Ech., part 1, p. 144.

Fragments of the abactinal surface of the test of a specimen of this species were collected off Bahia, which show that the large tubercles within the peripetalous fasciole carry large long curved spines like those of *Breynia*, *Lovenia*, *Maretia*, *Eupatagus* and the like. The spines near the posterior extremity and close to the ambitus, as well as on the actinal side, are stouter and longer than the uniform coating of spines covering the greater part of the abactinal surface of the test outside of the peripetalous fasciole. The size of the tubercles indicates well in a general way the proportion and character of the spines. The colour of the spines in alcohol is a pinkish buff.

Off Bahia.

Schizaster.

Schizaster, Agassiz, 1836, Prod.

It will evidently be extremely difficult when including the fossil species to separate satisfactorily many of the fossil species of *Linthia* from *Schizaster*, the passage being very gradual from species having the typical facies of *Brissus* with the lateral fasciole of *Agassizia* and *Schizaster*, to species in which the sunken petals, more or less broad and sunken anterior ambulacrum, and the general outline of the test approach the more or less globular species of *Schizaster*. Yet among the recent forms the only two species known seem to indicate very distinct generic differences. See more specially the description of a very typical and most interesting new species of *Linthia*, by Mr E. A. Smith in Ann. and Mag. Nat. Hist., 1878, vol. i. p. 67.

From the species of *Linthia*, combining many of the characters of *Schizaster*, there is

on the one hand but a step to species which have been associated with *Prenaster*, leading to *Pericosmus*, and which in their turn lead most naturally to *Macropneustes*, and of such types as *Brissomorpha* of Laube, in which the peripetalous fasciole has completely disappeared ; while in another direction the structure of these species would also indicate affinities to such genera as *Faorina*, which in their turn lead to such genera as *Cyclaster*, to which many fossil species are frequently referred without reference to the presence or absence of a peripetalous fasciole.

We have not as yet sufficient data, for the study of the young *Schizaster*, to enter into very detailed comparisons, but the following points are interesting as throwing additional light on the affinities of the genera allied to the Schizasteridæ :—

The limits which have been assigned to the genera closely allied to *Schizaster* are very unsatisfactory, and the generic characters by which different species are assigned to these genera or sub-genera pass so gradually one into the other, not merely among the recent species, but especially when we come to include the fossil species, that the task of properly limiting them appears hopeless, although these characters are convenient as subdivisions according to which we may associate groups of species.

Take, for instance, species like *Schizaster canaliferus*, with a broad, deep sunken anterior ambulacrum, a short posterior lateral pair of ambulacra, and a well-developed lateral fasciole extending under the anal system, and they seem to form a well-marked group when contrasted to species like *Schizaster moseleyi*, in which the test is comparatively flattened, the anterior ambulacrum broad but shallow, and where no lateral fasciole exists, having the course of that of *Schizaster canaliferus*, or but slight traces of it, exist as an indistinct branch of an anal fasciole ; while in other species *Schizaster fragilis* and *Schizaster philippii*, having the same general facies as *Schizaster moseleyi*, we have not thus far found the variation in the course and extent of this lateral fasciole, but it is quite as well defined as in *Schizaster canaliferus;* while again such a group as that to which *Schizaster ventricosus* and *Schizaster gibberulus* belong has the more deeply sunken ambulacra of *Schizaster canaliferus*, without a lateral fasciole but very distinct anal fasciole, and yet has the low flattened test of *Schizaster philippii* and *Schizaster fragilis*.

The small specimens (from 12–19 mm.) of young *Schizaster ventricosus*, *Schizaster japonicus*, and *Schizaster moseleyi* collected by the Challenger, show already the specific characters sufficiently well developed to enable us readily to assign them to their respective species ; the difference in outline in the test is, however, quite marked, and the test of all these species is much more globular than in the adult, and in one specimen of *Schizaster moseleyi* the test was, as in young specimens of *Brissopsis*, nearly globular, with a slightly indented peripetalous fasciole, and the suckers of the odd anterior ambulacrum already developed out of proportion to the rest of the test. The anal fasciole is quite well marked in the smallest specimens of *Schizaster ventricosus*, but the latero-anal fasciole of *Schizaster japonicus* is occasionally interrupted on the sides of the test in small specimens, evidently

showing that the lateral fasciole is an extension of the anal fasciole, and that as far as we know the lateral and anal fascioles, when they appear independently or united, are of greater permanence than when the anal fasciole appears as a branch of the subanal fasciole.

These young Schizasteridæ show very plainly that such genera as *Aceste* are strictly embryonic Schizasteridæ; that is, they retain as the young of *Schizaster* very rudimentary posterior lateral ambulacral petals, the odd anterior ambulacrum occupies the greater part of the abactinal surface of the test, the ambulacral suckers of this odd ambulacrum retain the gigantic size for which they are marked in the younger stages, and the peripetalous fasciole follows closely the lines drawn from the extremities of the petals. At a still earlier stage when *Schizaster* is more globular, it assumes a still more embryonic stage as the young of *Brissopsis*, that is, it passes then through what might be called its *Hemiaster* stage, and of this stage, when the actinostome is as yet not developed, *Aërope* is the representative at the present day; having the prominent peripetalous fasciole, the greatly developed odd anterior ambulacrum, but slightly sunken at first in the *Aceste* stage, and scarcely flush with the test in the *Hemiaster* stage, with its gigantic ambulacral suckers, and the more or less cylindrical shape so characteristic of all young Spatangoids. To a certain extent *Agassizia* may be regarded also as an embryonic type; it retains the globular shape of young Spatangoids, and the structure of the petals is embryonic in part. The presence of a well developed lateral fasciole dates back to the cretaceous *Prenaster*.

The unsatisfactory nature of the characters derived from the extent and course of the lateral fasciole is well shown from the subdivisions of *Faorina* attempted by Troschel, which are based mainly on the fascioles. Although the presence of a peripetalous fasciole appears greatly to modify the character of the abactinal part of the ambulacra, yet we are not able to make any classification of the Spatangoids based on the presence or absence of fascioles alone which corresponds in any way to the other structural affinities. The Prymnodesmians of Lovén (Spatangoids with a subanal fasciole) unite such widely distant types as *Palæotropus*, *Spatangus*, *Brissus*, and *Breynia*; while among the Prymnadetes we find *Hemiaster*, *Desoria*, and *Schizaster*, and it is often very difficult, as in the case of *Urechinus* and many fossil genera, to decide whether they belong to the Adetes or either of the other groups, and we find in the Pourtalesiæ, for instance, otherwise closely allied genera which would in this character alone be placed either in the one group or the other.

Schizaster fragilis.

Brissus fragilis, Düb. o. Kor., 1844, Skand. Echin., p. 280.
Schizaster fragilis, Agassiz., 1847, C. R. Ann. Sc. Nat., vol. viii. p. 22.

The Challenger collected this species off the coast of Nova Scotia. It has also been dredged by the United States Fish Commission in the Gulf of Maine. This species like *Brissopsis lyrifera* and *Spatangus raschi*, has an extensive geographical range in the

Atlantic, as the accompanying widely-separated localities where it was collected by the Challenger indicate.

Station 49. May 20, 1873. Lat. 43° 3′ N., long. 63° 39′ W.; 83 fathoms; bottom temperature, 1·8° C.; gravel, stones.

Station 142. December 18, 1873. Lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms; bottom temperature, 8·3° C.; sand.

**Schizaster japonicus* (Pl. XXXVI. figs. 8–13; Pl. XLIII. fig. 26; Pl. XLV. figs. 7–10).

Schizaster japonicus, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 212.

In this species the posterior lateral ambulacra (Pl. XXXVI. fig. 11) form a more acute angle with the longitudinal axis than in *Schizaster ventricosus;* it has also a very distinct latero-anal fasciole (Pl. XXXVI. fig. 12), a smaller anal opening, and a more pointed posterior extremity. A prominent keel in the median posterior interambulacrum forms a high crest at that end of the test (Pl. XXXVI. fig. 12), while *Schizaster ventricosus* is remarkable for its comparatively flattened and rounded posterior extremity (Pl. XXXVI. figs. 1, 3).

The ambulacra are all more deeply sunken, much as in *Schizaster canaliferus* and *Schizaster fragilis.* The test is highest immediately behind the apical system in the odd interambulacrum (Pl. XXXVI. fig. 12). These characters are early developed, as a comparison of young specimens of *Schizaster ventricosus* and *Schizaster japonicus,* measuring respectively one-third and half an inch in length, readily shows. The peripetalous fasciole is broad, and made up of triangular-shaped bands at the angles, and especially at the points in the median ambulacral spaces; it runs nearly straight across the odd interambulacrum from the extremity of the posterior petals.

There are two large genital openings in the posterior lateral ambulacra and a minute one in the left anterior one, while in *Schizaster ventricosus* these three are equally developed (see Revis. Ech.). The apex is also more central in this species, and the peripetalous fasciole less angular than in *Schizaster ventricosus.* The lateral fasciole (Pl. XXXVI. fig. 12) extends under the anus, it is narrow and sharply marked; the posterior ambulacra are proportionally wider, the outline more angular, the test swollen, and pointed at the posterior extremity when seen from above (compare Pl. XXXVI. figs. 11 and 12).

This form of *Schizaster,* and such forms as *Moiropsis claudicans,* readily pass on the one side into *Moira,* with its still more deeply sunken ambulacral plates, and comparatively ovoid and angular test, and into those fossil species of *Schizaster,* which have generally been associated with *Linthia.*

It is interesting to note with reference to the development of the fascioles, that in a young specimen measuring 12 mm. in length the lateral fasciole is indistinct near its

junction with the peripetalous fasciole. The arrangement of the spines is somewhat peculiar; in addition to the usually larger spines found in Schizasteroids on the edges of the petals and of the odd ambulacral groove, tufts and patches of considerable size of similar larger spines are found as in other genera, not only on each side of the anal system and at the extremity of the actinal beak (Pl. XXXVI. fig. 9), but also in the ambital region of the lateral anterior interambulacral areas (Pl. XXXVI. figs. 8, 10), and in the anterior half of the lateral posterior interambulacral areas from the posterior edge of the anterior lateral petals to the edge of the test (Pl. XXXVI. fig. 10). The rest of the abactinal surface of the test is covered with short spines of nearly uniform length and size. On the actinal side the spines are longer, coarser, and more distant (Pl. XXXVI. fig. 9), corresponding to the tuberculation of that region (Pl. XXXVI. fig. 13).

The pedicellariæ of *Schizaster japonicus* (Pl. XLIII. fig. 26; Pl. XLV. figs. 7–10), are stout-headed and stout-stemmed, few in number, scattered irregularly on the test, and stand out prominently from the test owing to their dark violet colour.

Station 188. September 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E.; 28 fathoms; mud.

Station 233*b*. May 26, 1875. Lat. 34° 20′ N., long. 133° 35′ E.; 15 fathoms; mud.

Off Yokohama; 8 to 14 fathoms.

Hong Kong, outside harbour; 10 fathoms. December 22, 1874. Kobi, Japan; 8 to 50 fathoms. May 18 and 19, 1875.

**Schizaster moseleyi*, n. sp. (Pl. XXXVI. figs. 14–16).

The general facies of this species recalls *Schizaster fragilis* and *Schizaster philippii*; it has like these species a flattened test, lateral ambulacra only slightly sunken, a broad odd anterior ambulacrum with angular edges on the abactinal side and three genital openings. It has, however, like *Schizaster gibberulus* and *Schizaster ventricosus* no latero-anal fasciole, some specimens showing a delicate and most indistinct anal fasciole. The position of the apex is intermediate between that which it occupies in such species as *Schizaster fragilis* and in *Schizaster canaliferus*. The colouring is like that of *Schizaster philippii* (when in alcohol), of an olive green.

In young specimens measuring about 15 mm. the outline is much the same as in the adult (55 mm.); the posterior extremity of the peripetalous fasciole is more pointed owing to the small size of the posterior pair of lateral ambulacra, which are reduced to two or three pairs of pores; with increasing size this part of the fasciole broadens in proportion to the increase in width of the posterior lateral ambulacra.

Station 311. January 11, 1876. Lat. 52° 50′ S., long. 73° 53′ W.; 245 fathoms; bottom temperature, 7·7° C.; mud.

Station 307. January 4, 1876. Lat. 49° 24′ S., long. 74° 23′ W.; 147 fathoms; bottom temperature, 7·6° C.; mud.

Station 309. January 8, 1876. Lat. 50° 56′ S., long. 74° 15′ W.; 40 to 140 fathoms; mud.

Station 310. January 10, 1876. Lat. 51° 30′ S., long. 74° 3′ W.; 400 fathoms; bottom temperature, 7·9° C.; mud.

Station 305. January 1, 1876. Lat. 47° 48′ S.; long. 74° 48′ W.; 120 fathoms; mud.

Off London River, Kerguelen; 110 fathoms.

Off Christmas Harbour, Kerguelen; 120 fathoms.

Station 146. December 29, 1873. Lat. 46° 46′ S., long. 45° 31′ E; 1375 fathoms; bottom temperature, 1·5° C.; globigerina ooze.

Schizaster ventricosus (Pl. XXXVI. figs. 1–3).

Schizaster ventricosus, Gray, 1851, Ann. Mag. Nat. Hist., vol. vii. p. 133.

As I refer so frequently to this species in the comparative descriptions of the different species of *Schizaster*, and as it is most typical of a special group of species, I have given figures of it to facilitate the comparisons and to illustrate the affinities of the different species of Schizasteridæ.

Station 232. May 12, 1875. Lat. 35° 11′ N., long. 139° 28′ E.; 345 fathoms; bottom temperature, 5·0° C.; sandy mud.

Periaster (*Schizaster*).

Periaster, D'Orb., 1854, Pal. Franç. Terr. Crét., tom. vi. p. 269.

**Periaster limicola* (Pl. XXXV.[b] figs. 1–4; Pl. XXXIX. fig. 38; Pl. XL. figs. 1–6).

Schizaster (*Periaster*) *limicola*, A. Agassiz, 1878, Bull. Mus. Comp. Zool., vol. v. p. 293, pl. iii.

I cannot distinguish the specimens collected by the Challenger (Station 188) from the specimens dredged off the mouth of the Mississippi. The latter are very much larger than the Challenger specimens. This species was accidentally described first from specimens dredged by the "Blake;" the only marked difference in the specimens of the "Blake" and "Challenger" is in the course and distinctness of the anal fasciole, which is more indistinct in specimens collected by the latter, and difficult to trace in the midst of the small tubercles covering the anal extremity of the test.

The two Challenger specimens were still covered with spines at the time I examined the "Blake" Echinoidea, and it was only subsequently that I became aware of their identity. On the actinal plastron the primary spines are spathiform, the spines of the anterior part of the test of the actinal and abactinal surface are longer than the others, curved, gradually diminishing in size towards the apical system, though longer again on the edge of the petals; the sides of the test are covered with smaller spines increasing in length again towards the actinal keel and the anal face of the test. Within the peripetalous fasciole the spines are of an ashy violet tint and a silvery dull white over the rest of the test.

The facies of this species seems to indicate closer affinities of the genus *Periaster* to *Schizaster* than to *Linthia* with which I was (as Desor before me) inclined to associate it.

Station 188. September 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E.; 28 fathoms; mud.

**Moiropsis* (*Moira*) n. gen.

This genus has, like *Moira*, a peripetalous fasciole forming a seam immediately on the edge of the petals; it has also, like it and other Schizasteridæ, a well developed latero-anal fasciole, the odd anterior ambulacral petal well limited and similar to the others, and the petals sunken. This genus is intermediate between *Moira* and *Schizaster*, and shows that the affinity of these genera is far closer than had been suspected.

**Moiropsis claudicans* (Pl. XXXVI. figs. 4–7; Pl. XL. figs. 51–53).

Schizaster claudicans, A. Agassiz, 1879, Proc. Am. Acad., vol. xiv. p. 211.

This pretty little Schizaster is well characterised by the high posterior test, the vertical posterior extremity extending into a prominent beak (Pl. XXXVI. fig. 6), the sharp, narrow, clear-cut lateral fasciole, the narrow and deeply-sunken ambulacral petals fringed by an indistinct peripetalous fasciole (Pl. XXXVI. figs. 4, 7), its narrow actinal plastron (Pl. XXXVI. fig. 5), the position of the anal opening immediately under the abactinal edge of the posterior interambulacral keel, and the close uniform tuberculation of the test above the ambitus. The outline of the test is cordate, seen from the actinal side (Pl. XXXVI. fig. 5) broad, the ambulacral areas bare; the actinostome placed close to the anterior edge, about one-fourth of the length of the test. The peripetalous fasciole crosses the odd posterior and lateral posterior interambulacra close to the apical system, following the edge of the petals it crosses the anterior interambulacrum halfway in the petal and encloses the whole of the short anterior petal, which is shorter than the lateral anterior

ambulacra as in some of the fossil species, but longer than the posterior lateral ones. There are two indistinct genital openings in the posterior lateral ambulacra.

Seen in profile the abactinal outline of the test is nearly parallel to the actinal surface from the posterior extremity to the apical system; from there, however, it slopes rapidly towards the rounded anterior extremity forming the ambitus. The tuberculation of the actinal surface is most prominent towards the actinostome in the interambulacral areas, diminishing gradually in size towards the ambitus, where it runs into the granulation of the abactinal surface and sides of the test.

The beak formed by the posterior extremity of the actinal plastron is fully as much developed as in some species of *Echinocardium;* the lateral fasciole is sharply defined, and its course well marked as it passes under the anal system about halfway from the ambitus on the posterior extremity. This species recalls more in its outline some of the Tertiary species which have like it a somewhat prominent beak, such as *Schizaster archiacii* and *Schizaster vicinalis*, and the like, in spite of the great difference in the course of the peripetalous fasciole.

This species is also interesting as it shows how in *Schizaster* proper the sunken anterior ambulacrum is related on the one side to such genera as *Brissus* and the like in which the odd anterior ambulacrum is not petaloid, and on the other with genera such as *Moira* in which the ambulacra are all deeply pouched, while the equal development of the odd anterior petal with the others, is on the contrary a feature characteristic of genera not in the least closely allied to the Schizasteridæ such as *Spatangus* and the like. The sunken petals and the lateral fasciole of this species show its affinities to *Tripylus* in which we have, however, only the four lateral petals deeply sunken, the odd anterior one, on the contrary, being flush with the test as in *Faorina* and *Linthia.* This combination of the lateral and peripetalous fasciole with either more or less sunken lateral and odd ambulacral petals shows unsuspected affinities between such very widely differing genera as *Agassizia* on the one side, and *Moira* on the other, which are readily understood when we use as terms of comparison allied forms to either extreme, such as *Brissus, Faorina, Brissopsis, Hemiaster, Rhinobrissus, Linthia,* and *Schizaster* on the one side, and *Moira, Moiropsis, Tripylus, Hemiaster, Faorina,* and the like on the other.

Station 192. September 26, 1874. Lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud.

The preceding enumeration includes 139 species of Echinids, of which 87 were known before and 52 are new species. The species collected are distributed as follows:—11 Cidaridæ (of which 3 are new species), 2 Salenidæ (1 new species), 6 Arbaciadæ (1 new species), 7 Diadematidæ (3 new species), 12 Echinothuridæ all of which are new to science, 10 Echinometradæ (no new species), 16 Temnopleuridæ (3 new species), 11 Triplechinidæ

(1 new species), 15 Clypeastridæ (all known species), 2 Nucleolidæ (1 new species), 13 Pourtalesiæ (12 new species), 6 Ananchytidæ (5 new species), 10 Spatangina (all previously known species), 18 Brissina (10 new species).

GEOGRAPHICAL AND BATHYMETRICAL RANGE.

At the time I published the Revision of the Echini (1872–74) there were enumerated 207 species distributed in 89 genera. This was a very material reduction of the number of species formerly recognised, and yet it included a couple of the deep-sea species dredged by the "Porcupine" and all the deep-sea species (13) discovered up to that time by Mr Pourtalès. Of the strictly littoral species there were not known at that time more than 192 species and 74 genera. In the general list now given there are 297 species and 107 genera enumerated, making in all 90 species and 25 genera added to the former list in spite of the reduction in number by the cancelling of a few nominal species of the older lists; not more than ten well-characterised species have been added by various writers to the list of the Revision in addition to the species discovered by the deep-sea dredging expeditions.

This leaves 80 deep-sea species described since those of Mr Pourtalès; of these 49 were discovered by the "Challenger," and 41 by the "Porcupine," "Josephine," and "Blake." Or about one-third of the whole number of known species of Echinoidea have been discovered since the days of deep-sea dredgings; of these 5 were brought to light by the "Josephine," the same number by the "Porcupine"; twenty-eight have thus far been described from the Coast Survey Expeditions ("Blake," "Bibb," and "Hassler"), and 49 from the "Challenger."

One new genus was discovered by the "Porcupine," and one by the "Josephine," nine by the Coast Survey Expeditions, and 15 by the "Challenger." But in addition to these new genera, 7 genera previously only known from fossils, were added to the present list, either by the "Blake" (3), "Challenger" (2), "Josephine" (1), or "Porcupine" (1).

The following compendium of our knowledge of the geographical, bathymetrical, and geological range of the recent Echinids will be found convenient for reference in the discussions which follow.

The only species which are not included in this list are those of the "Gazelle." A preliminary report of these Echinids has been published by Dr Studer,[1] and I have in the descriptions of the species of the "Challenger" referred to the species which I consider as identical or closely allied. The species described by Studer are from comparatively shallow water, and probably all belong to the Littoral Fauna.

[1] Monatsber. der K. Akad. J. W., Berlin, Juli 1876.

List of the known Species of Recent Echinoidea, showing their Range in Depth, and their Principal Localities;[1] and giving an Indication of the Geological Distribution of the Genera.

Explanation of Letters, &c.

B. "Blake" and United States Coast Survey Expeditions.
C. "Challenger" Expedition (English).
J. "Josephine" „ (Swedish).
P. "Porcupine" Expedition (English).
Val. "Valorous" „ („).
* Species discovered by the Challenger.
× Previously known species collected by the Challenger.

In the Bathymetrical Range.

—250 B. means that the species extends from the shore to 250 fathoms, and that the greatest depths have been determined by the B. = "Blake" Expedition.

410–500 C. gives the upper and lower limits as determined by the C. = "Challenger" Expedition.

[180 J. that the species has only been collected at that depth by the J. = "Josephine" Expedition, and that nothing further is known of its bathymetrical range.

	Range in Depth. Fathoms.	Principal Localities.	Tertiary.	Cretaceous.	Jurassic.
DESMOSTICHA, Hæckel.					
CIDARIDÆ, Müller.					
GONIOCIDARIDÆ, Hæckel.					
Cidaris, Kl.			Eocene; Miocene; Pliocene. Austria; Switzerland; Malta; Italy; India; Australia.	Upper Chalk. Lower Chalk.	Jura; Lias. Trias.
C. metularia, Bl.	—	Red Sea; Mauritius; Cape of Good Hope; East India Islands; Sandwich Islands; Fiji Islands.			
C. thouarsii, Val.	—	Panama; Gulf of California.			
× *C. tribuloides*, Bl.	–250 B.	South Carolina; Florida; Brazil; Cape Palmas.			
Dorocidaris, A. Ag.			Eocene. North America; Austria.	Chalk.	Jura.
D. bartletti, A. Ag.	76–398 B.	Caribbean Islands.			
**D. blakii*, A. Ag.	158–450 B.	Florida; Caribbean Islands.			
**D. bracteata*, A. Ag.	15–100 C.	Amboyna.			
× *D. papillata*, A. Ag.	–874 B.	Norway; Shetland Islands; Mediterranean; Canaries; Florida; Caribbean Islands; St Paul Rocks; La Plata; Philippines.			
Phyllacanthus, Br.			Nummulite. India; Australia; Malta; France; North America.	Chalk.	Oolite (*Rhabocidaris*).
× *P. annulifera*, A. Ag.	–28 C.	Australia; Philippine Islands; Torres Straits.			
× *P. baculosa*, A. Ag.	–102 C.	Red Sea; Zanzibar; Mauritius; Philippines.			
P. dubia, Br.	—	Zanzibar; Bonin Islands; Australia.			
× *P. gigantea*, A. Ag.	—	Sandwich Islands; Mauritius.			
P. imperialis, Br.	—	Red Sea; East India Islands; Australia.			
× *P. verticillata*, A. Ag.	–8 C.	Society Islands; East India Islands; Australia; Sandwich Islands; Torres Straits.			
Stephanocidaris, A. Ag.					
S. bispinosa, A. Ag.	—	Australia; Malacca.			

[1] For detailed lists of localities see A. Agassiz, Revision of the Echini, part 1; Mem. Mus. Comp. Zool., vol. iii.; Ill. Cat., No. 7.

	Range in Depth. Fathoms.	Principal Localities.	Tertiary.	Cretaceous.	Jurassic.
Porocidaris, Des.					
**P. elegans*, A. Ag.	410–500 C.	Philippines; New Guinea; New South Wales.	Eocene; Miocene. France; Egypt; (Num.) India.	—	Jura.
P. purpurata, Wy. Thom.	[542 P.	Rockall; Shetland; Faroe Islands.			
P. sharreri, A. Ag.	123–351 B.	Caribbean Islands.			
Goniocidaris, Des.					
× *G. canaliculata*, A. Ag.	–1975 C.	Falkland Islands; Patagonia; Natal; Zanzibar; Marion Islands, Kerguelen; Australia; Heard Island—Antarctic.			
**G. florigera*, A. Ag.	100–129 C.	Philippines; Indian Archipelago.			
G. geranioides, Agass.	—	Australia; East Indies; Tasmania.			
× *G. tubaria*, Lütk.	–40 C.	Australia; Tasmania; New South Wales.			
SALENIDÆ, Agass.					
Salenia, Gray.					
S. gœsiana, Lov.	[180 J.	Caribbean Islands.	Eocene; Miocene. France; Australia.	Lower Chalk. Upper Chalk. France; England; Germany.	Upper Jura.
**S. hastigera*, A. Ag.	100–1850 C.	Philippines; Kermadec; Indian Archipelago; Bay of Biscay and Coast of Portugal.			
S. pattersoni, A. Ag.	175–450 B.	Caribbean Islands.			
× *S. varispina*, A. Ag.	60–1675 B. C.	Straits of Florida; Caribbean Islands; North Brazil; Ascension; Azores; Canaries.			
ARBACIADÆ, Gray.					
Arbacia, Gray.					
A. australis, Trosch.	—	Australia (?).	Late Tertiary. North America.		
× *A. dufresnii*, Gray.	–175 C.	Patagonia; Chili; Nightingale Islands.			
× *A. nigra*, A. Ag.	—	Patagonia; Chili; Peru; Philippines.			
A. punctulata, Gray.	–125 B.	Long Island Sound to West Florida; Yucatan.			
× *A. pustulosa*, Gray.	—	Mediterranean; Liberia; Brazil.			
A. spatuligera, A. Ag.	—	Chili; Peru.			
A. stellata, Gray.	—	Panama; Gulf of California.			
Podocidaris, A. Ag.					
**P. prionigera*, A. Ag.	1050–1075 C.	Philippines; New Guinea.	—	*Magnosia; Codiopsis.*	
× *P. sculpta*, A. Ag.	138–390 B.	Straits of Florida; Caribbean Islands.	—		
P. scutata, A. Ag.	[580 B.	Caribbean Islands.			
Cœlopleurus, Agass.					
C. floridanus, A. Ag.	56–1323 B.	Straits of Florida; Caribbean Islands.	Eocene; Crag. North America; France; England; Italy; (Num.) India.		
× *C. maillardi*, A. Ag.	82–102 C.	Bourbon; Philippines; Amboyna; Indian Archipelago.			

	Range in Depth. Fathoms.	Principal Localities.	Tertiary.	Cretaceous.	Jurassic.
DIADEMATIDÆ, Peters.					
Diadema, Schynv.					
D. mexicanum, A. Ag.	—	Acapulco; Cape St Lucas.			
× *D. setosum*, Gray.	–115 B.	West India Islands; Bermudas; Cape Verde Islands; Indian Ocean; Japan; Sandwich Islands; Fiji Islands; Philippines.			
Centrostephanus, Pet.					
C. coronatus, A. Ag.	—	Cape St Lucas.			
C. longispinus, Pet.	—	Palermo; Canary Islands.			
C. rodgersii, A. Ag.	—	Australia; New Caledonia.			
**Aspidodiadema*, A. Ag.					
**A. microtuberculatum*, A. Ag.	356–2225 C.	North Brazil; Tristan da Cunha; Macio; Chili; Juan Fernandez.			
**A. tonsum*, A. Ag.	100–1700 C.	Philippines; Kermadec; Macio.			
A. antillarum, A. Ag	451–1200 B.	Caribbean Islands.			
A. jacobyi, A. Ag.	95–287 B.	Caribbean Islands.			
Echinothrix, Pet.					
× *E. calamaris*, A. Ag.	—	Society Islands; East India Islands; Philippine Islands; Kandavu Reef.			
E. desorii, Pet.	—	Red Sea; Fiji Islands; Sandwich Islands.			
× *E. turcarum*, Pet.	—	Sandwich Islands; Fiji Islands; Japan; East India Islands; Red Sea; Zanzibar; Kandavu Reef.			
**Micropyga*, A. Ag.					
**M. tuberculatum*, A. Ag.	100–610 C.	Philippines; Fiji Islands.			
Astropyga, Gray.					
A. elastica, Stud.	[20	New Britain.			
× *A. pulvinata*, Agass.	–49 C.	Panama; Gulf of California; Torres Straits; Honolulu.			
A. radiata, Gray.	—	Zanzibar; East India Islands; Philippines.			
ECHINOTHURIDÆ, Wy. Thom.					
Asthenosoma, Grube.					
**A. coriaceum*, A. Ag.	240–315 C.	Fiji Islands.			
A. fenestratum, W. Thom.	[445 P.	Rockall; Bay of Biscay; West Coast Portugal.			
**A. gracile*, A. Ag.	150–255 C.	Philippines; New Zealand.			
**A. grubii*, A. Ag.	[10 C.	Philippines.			
A. hystrix, A. Ag.	100–445 B. P.	Florida; Rockall to Rona; Caribbean Islands; Cape Finisterre.	...	Chalk. England (*Echi thuria*).	
**A. pellucidum*, A. Ag.	100–129 C.	Philippines; Indian Archipelago.			
**A. tessellatum*, A. Ag.	100–115 C.	Philippines.			
A. varium, Grube.	—	China Seas; Java Seas.			
A. reynoldsi, A. Ag.	180–375 B.	Caribbean Islands.			

	Range in Depth. Fathoms.	Principal Localities.	Tertiary.	Cretaceous	Jurassic.
Phormosoma, Wy. Thom.					
**P. asterias*, A. Ag.	[2160 C.	Juan Fernandez to Chili.			
**P. bursaria*, A. Ag.	255–1050 C.	Japan; Philippines.			
**P. hoplacantha*, Wy. Th.	410–1375 C.	Japan; New South Wales; Juan Fernandez to Chili.			
P. luculentum, A. Ag.	255–1050 C.	Philippines; Indian Archipelago.			
P. placenta, Wy. Thom.	500–800 P.	West Coast of Scotland and Ireland.			
**P. rigidum*, A. Ag.	700–1400 C.	New South Wales.			
**P. tenue*, A. Ag.	1875–2750 C.	Sandwich Islands to Low Archipelago; Japan.			
**P. uranus*, Wy. Thom.	1000–1525 C.	Portugal; Azores.			
P. sigsbii, A. Ag.	120–1242 B.	Caribbean Islands; Atlantic Coast of U.S. (Mid. States).			
P. petersi, A. Ag.	399–1224 B.	Caribbean; Atlantic Coast of U.S. (Middle and Southern States).			
ECHINOMETRADÆ, Gray.					
Colobocentrotus, Br.	—	Zanzibar; Java; Sandwich Islands; Chili.			
C. atratus, Br.	—	Bonin Islands; Australia.			
C. mertensii, Br.					
Heterocentrotus, Br.					
× *H. mammillatus*, Br.	—	Sandwich Ids.; E. India Ids.; Red Sea; Fiji Ids.; Kandavu Reef.			
× *H. trigonarius*, Br.	—	Mauritius; Java; Sandwich Ids; Fiji Ids.; New Caledonia.			
Echinometra, Rondel. (Breyn.)					
× *E. lucunter*, Bl.	-18 C.	Zanzibar; Red Sea; E. India Ids.; Japan; Sandwich Ids.; Fiji Ids.; Philippines; Kandavu.			
E. macrostoma, A. Ag.	—	West Coast of Africa.			
E. oblonga, Bl.	—	Sandwich Islands; Philippine Islands; Seychelle Islands.	Pliocene. North America.		
× *E. subangularis*, Desml.	-250 B.	Senegal; Cape Verde; Brazil; W. India Islands; Bermudas; Ascension.			
E. van brunti, A. Ag.	—	Peru; Panama; Gulf of California.			
E. viridis, A. Ag.	—	Florida; Hayti.			
Parasalenia, A. Ag.					
P. gratiosa, A. Ag.	—	Kingsmills Islands; Bonin Islands; Zanzibar; New Caledonia; Fiji Islands.			
Stomopneustes, Agass.					
S. variolaris, Agass.	—	Mauritius; Java; Samoa.	Nummulite; Miocene. India; Java.		
Strongylocentrotus, Br.					
S. albus, A. Ag.	—	Patagonia; Chili; Peru; Philippines.			
S. armiger, A. Ag.	—	Australia.			
S. depressus, A. Ag.	—	Japan.			
× *S. dröbachiensis*, A. Ag.	-78	North European; North Pacific; North East Coast of America.	Miocene; Pliocene. North America; Sweden; Java.		
× *S. eurythrogrammus*, A. Ag.	-35 C.	Australia; Tasmania; Samoa; New Caledonia; New South Wales.			

	Range in Depth. Fathoms.	Principal Localities.	Tertiary.	Cretaceous.	Jurassic.
Strongylocentrotus—continued.					
S. franciscanus, A. Ag.	—	Formosa; Puget Sound; San Diego; Japan.	Miocene; Pliocene. North America; Sweden; Java.		
S. gaimardi, A. Ag.	—	Brazil.			
× *S. gibbosus*, A. Ag.	-45 C.	Chili; Galapagos; Peru; Fiji Islands; West Patagonia.			
S. intermedius, A. Ag.	—	Japan; Australia.			
S. lividus, Br.	—	European Atlantic; Mediterranean; Azores; Brazil.			
S. mexicanus, A. Ag.	—	Gulf of California.			
S. nudus, A. Ag.	—	Sandwich Islands; Japan.			
S. purpuratus, A. Ag.	—	San Francisco; Puget Sound.			
S. tuberculatus, Br.	—	Japan; China; Australia; New Zealand; Galapagos.			
Sphærechinus, Des.			Pliocene. Italy; Austria.		
× *S. australiæ*, A. Ag.	-40 C.	Australia; Mauritius; New Zealand; New South Wales.			
× *S. granularis*, A. Ag.	-400 C.	Mediterranean; Canary Islands; West Coast France; Azores; St Vincent.			
S. pulcherrimus, A. Ag.	—	Japan; China Seas.			
Pseudoboletia, Trosch.					
P. granulata, A. Ag.	—	Sandwich Islands.			
× *P. indiana*, A. Ag.	-10 C.	Philippine Islands; Mauritius.			
Echinostrephus, A. Ag.					
E. molare, A. Ag.	—	Society Islands; Zanzibar; Natal; Sandwich Islands; East India Islands.			
ECHINIDÆ, Agass.					
TEMNOPLEURIDÆ, Des.					
Temnopleurus, Agass.			Eocene; Miocene. India; Java; Egypt.		
× *T. hardwickii*, A. Ag.	-129 C.	Japan; Kamtchatka; Philippines; Arafura Sea.			
× *T. reynaudi*, Agass.	-275 C.	Ceylon; China Seas; East India Islands; Philippines; New Zealand.			
× *T. toreumaticus*, Agass.	-20 C.	Bombay; East India Islands; China; Gulf of Persia; Philippines.			
Pleurechinus, Agass.					
× *P. bothryoides*, Agass.	—	(Galapagos?); Japan; Arafura Sea.			
Temnechinus, Forbes.					
T. maculatus, A. Ag.	30-600 B. J.	Straits of Florida; Azores; Josephine Bank; Caribbean Islands.	Crag. Australia; India.	Cretaceous.	
**Prionechinus*, A. Ag.					
**P. sagittiger*, A. Ag.	700-1070 C.	Philippines; New South Wales.			
Cottaldia, Des.					
**C. forbesiana*, A. Ag.	310-315 C.	Fiji Islands.	Eocene; Miocene.	Chalk.	
Microcyphus, Agass.					
M. maculatus, Agass.	—	Japan; Navigator Islands; East India Islands.			
× *M. zigzag*, Agass.	-40 C.	Japan; Philippine Islands; Tasmania; New South Wales.			

	Range in Depth. Fathoms.	Principal Localities.	Tertiary.	Cretaceous.	Jurassic.
Trigonocidaris, A. Ag.					
T. albida, A. Ag.	60–450 B.	Straits of Florida; Caribbean Islands; Josephine Bank.	Australian (*Paradoxechinus*).		
**T. monolini*, A. Ag.	[520 C.	Kermadec Islands.			
Salmacis, Agass.					
×*S. bicolor*, Agass.	-10 C.	Red Sea; Mozambique; Bombay; Philippines.	Eocene; Pliocene. Italy.		
×*S. dussumieri*, Agass.	-100 C.	China Seas; East India Islands; Philippines.			
×*S. globator*, Agass.	-8 C.	Australia; Arafura Sea.			
×*S. rarispina*, Agass.	-28 C.	Philippine Islands; Siam; China Seas; Arafura Sea.			
×*S. sulcata*, Agass.	—	Australia; Philippine Islands; Mozambique; Red Sea.			
Mespilia, Des.					
×*M. globulus*, Agass.	-10 C.	Japan; Philippine Islands; Sandwich Islands.			
Amblypneustes, Agass.					
×*A. formosus*, Val.	-40 C.	Australia; New South Wales.	Eocene. Swiss; Italian (*Leiopedina chrysomelon*).		
A. griseus, Agass.	—	Australia; New Zealand.			
A. ovum, Agass.	—	Australia.			
A. pallidus, Val.	—	Australia; Fiji Islands.			
A. pentagonus, A. Ag.	—	Mauritius (?).			
Holopneustes, Agass.					
H. inflatus, A. Ag.	—	Australia.	Eocene (*Leiopedina*).		
H. porosissimus, Agass.	—	Australia.			
×*H. purpurescens*, A. Ag.	-15 C.	Australia; New South Wales.			
Triplechinidæ, A. Ag.					
Phymosoma, Haime.					
P. crenulare, A. Ag.	—	Japan.	Eocene.	Lower Chalk.	
Hemipedina, Wright.					
H. cubensis, A. Ag.	138–270 B.	Straits of Florida.	North America.	Lower Chalk.	Jura.
Echinus, Rond. (Linn.)					
×*E. acutus*, Lamk.	-1350 C.	Norway; Shetland Islands; Mediterranean; Ascension; Halifax to New York; Kermadec Islands.	Eocene; Miocene; Pliocene. England (Crag); France; Malta; Austria; India; North America.	Cretaceous.	
E. albocinctus, Hutt.	—	New Zealand.			
×*E. angulosus*, A. Ag.	-20 C.	Cape of Good Hope; Mauritius; Red Sea; Philippines; New Zealand; Australia.			
E. darleyensis, Wood.	—	Australia.			
×*E. elegans*, Düb. o. Kor.	80–1350 C.	Norway; off Valencia; Mediterranean; Halifax to New York; Tristan da Cunha; Papua.			
E. elevatus, Hutt.	—	New Zealand.			
E. esculentus, Linn.	—	Norway; English Channel.			
E. gracilis, A. Ag.	93–200 B.	Straits of Florida; West India Islands.			
**E. horridus*, A. Ag.	[175 C.	Straits of Magellan; West Patagonia.			

	Range in Depth. Fathoms.	Principal Localities.	Tertiary.	Cretaceous.	Jurassic.
Echinus—continued.					
× *E. magellanicus*, Phil.	–1600 C.	Patagonia; Chili; New Zealand; Australia; Cape of Good Hope to Marion Island to Kerguelen; Falkland Islands.			
× *E. margaritaceus*, Lamk.	–245 C.	West Patagonia; Straits Magellan; New Zealand; Kerguelen; Heard Island.	Eocene; Miocene; Pliocene. England (Crag); France; Malta; Austria; India; North America.	Cretaceous.	
E. melo, Lamk.	–190.	Mediterranean; Canaries; Cape Verde Islands.			
E. microstoma, W. Th.	150–450 P.	West Coast Scotland and Ireland.			
E. microtuberculatus, Bl.	—	Mediterranean; Cape Verde Ids.			
E. miliaris, Müll.	—	Norway; English Channel.			
× *E. norvegicus*, Düb. o. Kor.	80–2435 B. P.	Norway; off Valencia; Mediterranean; Straits of Florida; Atlantic Coast of U. S.; Japan; West Patagonia.			
E. wallisi, A. Ag.	257–1047 B.	Atlantic Coast of U. S. (Southern and Middle States).			
Toxopneustes, Agass.					
T. maculatus, A. Ag.	—	Christmas Island; Bourbon.			
× *T. pileolus*, Agass.	–10 C.	Panama; East India Islands; Fiji Islands; Mauritius; New Caledonia; Sandwich Islands; Philippines.	North America (West Indian).		
T. semituberculatus, Ag.	—	Galapagos; West Coast Central America; Cape St Lucas.			
× *T. variegatus*, A. Ag.	–300 B.	Bermudas; South Carolina; West India Islands; Brazil; Straits of Florida.			
Hipponoë, Gray.					
H. depressa, A. Ag.	—	Gulf of California.			
H. esculenta, A. Ag.	–451 B.	Florida; Yucatan; West Indies; Surinam; Bermudas;	Miocene. France.		
× *H. variegata*, A. Ag.	–15 C.	Sandwich Islands; Japan; East India Islands; Fiji Islands; Red Sea; Mozambique; Philippines; Kandavu Reef; New South Wales.			
Evechinus, Verrill.					
× *E. chloroticus*, Verrill.	—	New Zealand; Kandavu Reef.			
CLYPEASTRIDÆ, Agass.					
ECHINOCONIDÆ, d'Orb.					
Pygaster, Agass.					
P. relictus, Lov.	[180 J.	West India Islands.		Cretaceous.	Jura.
EUCLYPEASTRIDÆ, Hæck.					
FIBULARINA, Gray.					
Echinocyamus, Van Phelps.					
× *E. pusillus*, Gray.	–805 B.	Norway; Iceland; Mediterranean; Azores; Florida; Caribbean Ids.; North Brazil.	Miocene. Switzerland; Austria; France.	Upper Chalk. France; Belgium; Sicily.	

	Range in Depth. Fathoms.	Principal Localities	Tertiary.	Cretaceous.	Jurassic.
Fibularia, Lamk.					
× *F. australis*, Desml.	-950 C.	Sandwich Islands; Japan; Australia; Kingsmills Islands; New South Wales.	Eocene. Italy.	Danien. Belgium.	
F. ovulum, Lamk.	—	Indian Ocean; Philippine Islands.			
× *F. volva*, Agass.	-28 C.	Red Sea; Formosa; North Australia.			
ECHINANTHIDÆ, A. Ag.					
Clypeaster, Lamk.					
× *C. humilis*, A. Ag.	-20 C.	Red Sea; East India Islands; New Caledonia; Philippines; Amboyna.	Eocene; Miocene; Pliocene. North America; West Indies; Italy; Corsica; Egypt; Java.		
C. rotundus, A. Ag.	—	Panama; San Diego.			
× *C. scutiformis*, Lamk.	—	Red Sea; Philippine Islands; Kingsmills Islands; Japan; New Caledonia.			
× *C. subedepressus*, Agass.	-120 B.	West Coast of Africa; South Carolina; Florida; Brazil; West India Islands.			
Echinanthus, Breyn.					
E. rosaceus, Gray.	-118 B.	West India Islands; Florida; South Carolina.	Eocene; Miocene; Pliocene. Austria; Corsica; Malta; Caucasus; India; Java; Australia.		
× *E. testudinarius*, Gray.	-120 C.	Australia; Japan; Sandwich Islands; Gulf of California; New South Wales.			
LAGANIDÆ, Des. (Emend.)					
Laganum, Kl.					
L. bonani, Kl.	—	Tasmania; East India Islands; Philippine Islands.	Eocene; Miocene; Pliocene. Java; North America; Egypt.		
× *L. depressum*, Less.	—	Kingsmills Islands; Fiji Islands; Philippine Islands; Australia; Zanzibar; Arafura Sea.			
× *L. putnami*, Barn.	-25 C.	Japan; Amboyna.			
Peronella, Gray.					
× *P. decagonalis*, A. Ag.	-315 C.	Japan; New Caledonia; Bay of Bengal; East India Islands; Tahiti; Philippines; Tonga; Arafura Sea.			
P. orbicularis, A. Ag.	—	Australia; Formosa.			
× *P. peronii*, Gray.	-40 C.	Tasmania; Philippine Islands; New South Wales.			
P. rostrata, A. Ag.	—	New Zealand; Zanzibar.			
SCUTELLIDÆ, Agass.					
Echinarachnius, Leske.					
E. excentricus, Val.	—	California; Alaska; Kamtchatka.	North America; Patagonia; Australia.		
E. mirabilis, A. Ag.	—	Japan; Aleutian Islands.			

	Range in Depth. Fathoms.	Principal Localities.	Tertiary.	Cretaceous.	Jurassic.
Echinarachnius—continued.					
E. parma, Gray.	–306 B.	New Jersey; Labrador; off George's Bank, Vancouver Island; Kamtchatka; Aleutian Islands; Japan; Australia; India; Red Sea.	North America; Patagonia; Australia.		
Arachnoides, Kl.					
A. placenta, Agass.	—	New Zealand; Australia; East India Islands; Burmah.	Miocene. California (*Asterodaspis* ?) Australia.		
Echinodiscus, Breyn.					
E. auritus, Leske.	—	Zanzibar; Philippine Islands.	France; Austria.		
E. biforis, A. Ag.	—	Mozambique; Red Sea; Java; Cape of Good Hope.			
× *E. lævis*, A. Ag.	—	Japan; New Caledonia; East India Islands; South Africa.			
Mellita, Kl.					
M. erythræa, Gray.	—	Red Sea (?).	Pleistocene. North America.		
M. longifissa, Mich.	—	Panama; Gulf of California.			
M. pacifica, Verrill.	—	Peru.			
× *M. sexforis*, A. Ag.	–270 B.	West India Islands; South Carolina; Bermudas; Brazil.			
M. stokesii, A. Ag.	—	Guayaquil; Panama; Galapagos.			
M. testudinata, Kl.	–7 B.	Brazil; West India Islands; North and South Carolina; Nantucket.			
Astriclypeus, Verrill.					
× *A. manni*, Verrill.	—	China; Japan.			
Rotula, Kl.					
R. augusti, Kl.	—	Liberia.			
R. rumphii, Kl.	—	Senegal; Cape Verde Islands.			
Encope, Agass.					
E. californica, Verrill.	—	Gulf of California.	Pleistocene. North America.		
× *E. emarginata*, A ass.	–70 C.	Brazil; West Indies; Yucatan; Florida; South Carolina.			
E. grandis, Agass.	—	Gulf of California.			
E. michelini, Agass.	–11 B.	Yucatan; Florida.			
E. micropora, Agass.	—	Panama; Gulf of California.			
PETALOSTICHA, Hæckel.					
CASSIDULIDÆ, Agass.					
ECHINONEIDÆ, Agass.					
Echinonëus, Van Phel.					
E. cyclostomus, Leske.	—	Australia; Kingsmills Islands; Zanzibar; East India Islands.	Miocene. North America; West Indies.		
E. semilunaris, Lamk.	—	Florida; West India Islands.			
NUCLEOLIDÆ, Agass.					
Neolampas, A. Ag.					
N. rostellata, A. Ag.	100–690 B. P.	Straits of Florida; Caribbean Islands; North-East Atlantic.			

	Range in Depth. Fathoms.	Principal Localities.	Tertiary.	Cretaceous.	Jurassic.
Echinolampas, Gray.			European; Switzerland; Austria; Italy; India; Java; Australia; Cuba; North America; West Indies.		
E. alexandri, Lor.	—	Mauritius.			
E. depressa, Gray.	-160 B.	Straits of Florida; Caribbean Islands.			
E. hellei, Val.	—	Senegal.			
×*E. oviformis*, Gray.	-129 C.	Red Sea; Molucca; Cape of Good Hope; Mauritius; Indian Archipelago.			
Conoclypus, Agass.			Eocene; Miocene. Austria; Switzerland; Italy; Corsica; Crimea; India; West Indies.	Upper Chalk. France.	
C. sigsbei, A. Ag.	84–450 B.	Straits of Florida; Yucatan.			
Catopygus, Agass.			Australia; West Indies.	Upper, Middle, and Lower Chalk. Europe; India.	
**C. recens*, A. Ag.	[129 C.	Indian Archipelago.			
Rhynchopygus, D'Orb.			Australia; Crag; Switzerland; Cuba; West Indies.	Gault, India.	
R. caribbæarum, Lütk.	-106 B.	West India Islands.			
R. pacificus, A. Ag.	—	Galapagos; Panama; Gulf of California.			
Echinobrissus, Breyn.					
E. recens, D'Orb.	—	New Zealand; Madagascar.	Australia.	Cretaceous.	Middle and Upper Jura.
Nucleolites, Lamk.			Eocene; Miocene. Switzerland; North America; West Indies; Java.		
N. epigonus, Mart.	—	East India Islands.			
Anochanus, Grube.					
A. sinensis, Grube.	—	East India Islands.			
SPATANGIDÆ, Agass.					
POURTALESIÆ, A. Ag.					
Pourtalesia, A. Ag.			Crag (*Echinarachnius woodii*) (?).	*Infulaster.*	
**P. carinata*, A. Ag.	1950–2225 C.	Heard Island to Antarctic; Juan Fernandez to Chili.			
**P. ceratopyga*, A. Ag.	1950–2225 C.	Antarctic; Heard Islands to Australia; Juan Fernandez to Chili.			
**P. hispida*, A. Ag.	1600–1975 C.	Marion Island to Australia.			
P. jeffreysi, Wy. Th.	[690 P.	Faroe to Shetland Islands.			
**P. laguncula*, A. Ag.	345–2900 C.	Japan to Sandwich Islands; Japan; Arafura Sea; New Zealand.			
P. miranda, A. Ag.	242–1215 B. P.	Straits of Florida; Shetland Channel; Caribbean Islands.			
×*P. phiale*, Wy. Thom.	1215–1975 P. C. Val.	Kerguelen to Australia; North Atlantic; Rockall.			
**P. rosea*, A. Ag.	[2600 C.	Sandwich Islands to Low Archipelago.			
**Spatagocystis*, A. Ag.					
**S. challengeri*, A. Ag.	1600–1950 C.	Marion Island to Kerguelen, Australia.			

	Range in Depth. Fathoms.	Principal Localities.	Tertiary.	Cretaceous.	Jurassic.
**Echinocrepis*, A. Ag.					
**E. cuneata*, A. Ag.	[1600 C.	Marion Island to Kerguelen.			
**Urechinus*, A. Ag.					
**U. naresianus*, A. Ag.	1200–1800 B.C.	Marion Island to Kerguelen to Australia; Juan Fernandez to Straits of Magellan; Caribbean Islands.			
**Cystechinus*, A. Ag.					
**C. clypeatus*, A. Ag.	1050–1915 C.	Philippines; Tristan da Cunha to Bahia; Tristan da Cunha to Buenos Ayres.			
**C. vesica*, A. Ag.	1675–2225 C.	Antarctic to Kerguelen to Australia; Juan Fernandez to Chili.			
**C. wyvillii*, A. Ag.	1375–1825 C.	Marion Island to Kerguelen to Australia; Juan Fernandez to Chili.			
**Calymne*, Wy. Thom.					
**C. relicta*, Wy. Thom.	620–2650 C.	Azores.			
ANANCHYTIDÆ, Alb. Gras.					
Palæotropus, Lov.					
P. josephinæ, Lov.	82–250 B. J.	Caribbean Islands; Azores.			
**P. lovéni*, A. Ag.	[375 C.	Philippines.			
P. thomsoni, A. Ag.	[233 B.	Atlantic Coast of U. S. (So. Ca.).			
**Argopatagus*, A. Ag.					
**A. vitreus*, A. Ag.	[800 C.	Arafura Sea.			
**Genicopatagus*, A. Ag.			North America (*Holaster*, sp.).		
**G. affinis*, A. Ag.	[1950 C.	Antarctic; Kerguelen to Australia.			
Homolampas, A. Ag.			Italy.		
× *H. fragilis*, A. Ag.	300–1920 B.	Straits of Florida; North Brazil; Josephine Bank.			
**H. fulva*, A. Ag.	2425–2475 C.	Sandwich Islands to Low Archipelago.			
Paleopneustes, A. Ag.			Eocene.		
P. cristatus, A. Ag.	56–450 B.	Straits of Florida; Caribbean Isds.	Italy.		
P. hystrix, A. Ag.	21–208 B.	Caribbean Islands.			
**Linopneustes*, A. Ag.					
**L. murrayi*, A. Ag.	345–375 C.	Philippines; Japan.			
L. longispinus, A. Ag.	28–298 B.	Caribbean Islands.			
Platybrissus, Grube.					
P. rœmeri, Grube.					
SPATANGINA, Gray.					
Spatangus, Kl.			Eocene; Miocene; Pliocene. England; Westphalia; Switzerland; Italy; Palermo; Morea.		
S. lütkeni, A. Ag.	—	Japan.			
× *S. purpureus*, Leske.	–450 B. C.	Norway; Shetland Islands; Mediterranean; Caribbean Islands; Bermudas; Azores.			
× *S. raschi*, Lov.	150–300 P.C.	German Ocean; Azores; off Valencia; Shetland Islands; Cape of Good Hope.			

	Range in Depth. Fathoms.	Principal Localities.	Tertiary.	Cretaceous.	Jurassic.
Maretia, Gray.					
× *M. alta*, A. Ag.	-800 C.	Japan; Luzon; Arafura Sea.	Eocene; Miocene; Pliocene. France; Italy; India; Java; Australia.		
M. elliptica, Bol.	—	South Sea.			
× *M. planulata*, Gray.	-25 C.	Kingsmills Islands; China; East India Islands; New Caledonia; Mauritius; Australia; Levuka Reef.			
Nacopatagus, A. Ag.					
N. gracilis, A. Ag.	[65 B.	Juan Fernandez.			
Eupatagus, Agass.					
× *E. valenciennesii*, Agass.	—	Australia; Arafura Sea; New South Wales.	Eocene; Miocene; Pliocene. Australia; India; Egypt; Malta; Italy; Switzerland; France; West Indies.		
Lovenia, Des.					
L. cordiformis, Lütk.	—	Guyaquil; Gulf of California.	Crimea; Corsica; Java; Australia.		
× *L. elongata*, Gray.	-28 C.	Red Sea; Australia; Philippines; Arafura Sea; Cape of Good Hope.			
× *L. subcarinata*, Gray.	-10 C.	China; Luzon; Japan; Sandwich Islands.			
Breynia, Des.					
× *B. australasiæ*, Gray.	—	Red Sea; Australia; Japan; Sandwich Islands; Torres Straits.	Eocene; Miocene. France; Italy; Java; India; Cuba.		
Echinocardium, Gray.					
× *E. australe*, Gray.	-2675 C.	New Zealand; Australia; New South Wales; Tasmania; Japan; East India; Cape of Good Hope; Mozambique.	Eocene; Miocene; Pliocene. North America; England; Italy; India; Switzerland.		
E. cordatum, Gray.	-85 B.	Norway; Shetlands; Mediterranean; Brazil; Florida; North Carolina.			
× *E. flavescens*, A. Ag.	-150 B.	Norway; Shetland Islands; Cape of Good Hope; South Carolina; Florida.			
E. mediterraneum, Gray.	—	Mediterranean.			
E. pennatifidum, Norm.	79-121 B.	Northumberland; Shetland Islands; Straits of Florida.			
LESKIADÆ, Gray.					
Paleostoma, Lovén.					
P. mirabilis, Lovén.	—	China; East India Islands.			

	Range in Depth. Fathoms.	Principal Localities.	Tertiary.	Cretaceous.	Jurassic.
BRISSINA, Gray.					
Hemiaster, Des.			Cuba; North America; Europe; Malta; India; Java.	Upper Chalk. India; Europe.	
× *H. cavernosus*, A. Ag.	–400 C.	Patagonia; Chili; La Plata River; Straits of Magellan; Kerguelen; Heard Islands.			
H. expergitus, Lov.	464–485 B. J.	Caribbean Islands; East Atlantic; West Coast of Spain, lat. 38 N., long. 0·9 W.			
**H. gibbosus*, A. Ag.	345–800 C.	Japan; Arafura Sea.			
**H. zonatus*, A. Ag.	620–750 C.	Bahia; Canary Islands.			
H. mentzi, A. Ag.	170–576 B.	Caribbean Islands.			
Tripylus, Phil.					
T. excavatus, Phil.	—	Patagonia; Chili.			
Rhinobrissus, A. Ag.			Australia (*Micraster*, sp.).		
**R. hemiasteroides*, A. Ag.	[20 C.	Tahiti.			
R. micrasteroides, A. Ag.	175–242 B.	Caribbean Islands.			
R. pyramidalis, A. Ag.	—	China.			
**Cionobrissus*, A. Ag.					
**C. revinctus*, A. Ag.	[800 C.	Arafura Sea.			
Brissopsis, Agass.			England (Crag). France; Switzerland; Italy; India; North America; West Indies.		
× *B. luzonica*, A. Ag.	–1100 C.	Luzon; Siam; New Caledonia; Tahiti; New Zealand; Philippines; Japan; Arafura Sea.			
× *B. lyrifera*, Agass.	–2435 P.	Norway; Mediterranean; Florida; Greenland; Cape Good Hope; Caribbean Islands.			
**Aërope*, Wy. Thom.					
**A. rostrata*, Wy. Thom.	800–1750 C. Val.	Arafura Sea; Bay of Biscay; Davis Straits.			
**Aceste*, Wy. Thom.					
**A. bellidifera*, Wy. Thom.	[2600 C.	Sandwich Islands to Low Archipelago; Buenos Ayres to Tristan da Cunha; Canary Isds.			
**Agassizia*, Val.			Eocene; Miocene. North America; West Indies; Egypt.		
A. excentrica, A. Ag.	36–391 B.	Florida Gulf Stream; Caribbean Islands,			
A. scrobiculata, Val.	—	Peru; Panama; Gulf of California.			
Brissus, Kl.			Eocene; Miocene; Pliocene. North America; West Indies; Pyrenees; Malta; Italy; England; Java.		
B. carinatus, Gray.	—	Society Islands; Sandwich Islands; East Indies; Mauritius; Philippine Islands.			
**B. damesi*, A. Ag.	120–450 C.	North Brazil; Azores.			
B. obesus, Verrill.	—	Panama; Gulf of California.			
B. unicolor, Kl.	–7 B.	West India Islands; Cape Verde Islands; Mediterranean.			

	Range in Depth. Fathoms.	Principal Localities.	Tertiary.	Cretaceous.	Jurassic.
Metalia, Gray.					
M. africana, A. Ag.	—	Sherboro Islands.			
M. costæ, Lud.	–25	Mediterranean; Capri.			
× *M. maculosa*, A. Ag.	–28 C.	Samoa; Sandwich Islands; Australia; Mauritius; Panama; Gulf of California; Arafura Sea.	North America; West Indies; Malta; Italy.		
× *M. pectoralis*, A. Ag.	–156 B.	West India Islands; Florida; Brazil.			
M. sternalis, Gray.	—	Sandwich Islands; Society; Islands; East India Islands; Philippine Islands; Australia; New Caledonia; Red Sea.			
Meoma, Gray.					
M. grandis, Gray.	—	Acapulco; Gulf of California.	Australia; Cuba; West Indies.		
M. ventricosa, Lütk.	–242 B.	West India Islands; Straits of Florida.			
Linthia, Mer.					
L. australis, A. Ag.	—	Tasmania.	Eocene; Miocene. India; Europe.	Middle and Upper Chalk.	
L. rostrata, Smith.	—	Pacific Islands.			
Faorina, Gray.					
F. chinensis, Gray.	—	China; Sandwich Islands.			
Schizaster, Agass.					
S. canaliferus, Agass.	–37	Mediterranean.	Eocene. England; France; Switzerland; Austria; Italy; Malta; India; Java; Australia; North America; Cuba; West Indies.		
× *S. fragilis*, Agass.	71–955 B.	Norway; Gulf St Lawrence; Gulf of Maine; East Coast of U.S. Atlantic (middle States); Straits of Florida; Caribbean Islands; Cape of Good Hope.			
S. gibberulus, Agass.	—	Red Sea.			
**S. japonicus*, A. Ag.	8–50 C.	Off Japan; China; Arafura Sea.			
**S. moseleyi*, A. Ag.	40–1375 C.	Marion Island; Kerguelen; West Patagonia; Straits of Magellan.			
S. philippii, A. Ag.	—	Patagonia.			
× *S. ventricosus*, Gray.	–345 C.	Fiji Islands; Philippines; Siam; Japan.			
S. orbignyanus, A. Ag.	92–1507 B.	Caribbean Islands.			
Periaster, D'Orb.					
× *P. limicola*, A. Ag.	28–118 B. C.	Gulf of Mexico; Arafura Sea.	Eocene. Europe; Egypt; India; Java; West Indies.	Chalk. Egypt; France; North America.	
**Moiropsis*, A. Ag.					
**M claudicans*, A. Ag.	[129 C.	Indian Archipelago.			
Moira, A. Ag.					
M. atropos, A. Ag.	–60 B.	West Indies; North and South Carolina; Straits of Florida.	West Indies.		
M. clotho, A. Ag.	—	Gulf of California.			
M. stygia, A. Ag.	—	Red Sea (?); Zanzibar (?).			

We may for the present, for the purpose of showing the extent of the bathymetrical range, subdivide the preceding table into three groups, which I will call the Littoral, the Continental, and the Oceanic or Abyssal.

The divisions into littoral, continental and abyssal or oceanic are not arbitrary; they represent in the present state of our knowledge of the depths of the oceans, bathymetrical lines of great physical importance. The littoral fauna extends over that shallow area of the shores which is merely the extension under water of the shores themselves (to 100 or 150 fathoms); the continental line represents the extent to which we may fairly assume that the lines of continents have been modified, the limits within which probably subsidence and elevation as affecting continental masses, or rather their shores, have taken place, to 450 or 500 fathoms, while the third region beyond this, that which has been called abyssal or oceanic, undoubtedly represents those large areas of the ocean floor which have remained unaffected through long geological periods. This view is gradually gaining ground among geologists, and was one of the very first results arrived at by the late Professor Agassiz in his discussions of the results of the dredgings of Mr Pourtalès in 1866 and 1867. He had previously followed Guyot[1] and Dana[2] and come to the conclusions that the present continental areas, or at least their skeletons, are of very ancient origin, and that the great oceanic basin had remained practically undisturbed from the earliest geological periods.[3] It may not be out of place to repeat here a part of Professor Agassiz's argument:—"From what I have seen of the deep-sea bottom I am already led to infer that among the rocks forming the bulk of the stratified crust of our globe, from the oldest to the youngest formation, there are probably none which have been formed in very deep waters. If this be so, we shall have to admit that the areas now respectively occupied by our continents as circumscribed by the two hundred fathom curve or thereabout, and the oceans at greater depth, have from the beginning retained their relative outline and position; the continents having at all times been areas of gradual upheaval with comparatively slight oscillations of rise and subsidence, and the oceans at all times areas of gradual depression with equally slight oscillations." The same view has been adopted by Geikie.[4]

This was practically the same view developed by Thomson in the Depths of the Sea, and previously in a lecture delivered before the Royal Institution in April 1869, and the subject was greatly advanced by the analysis made by Mr Murray[5] of the nature of the deposits on the ocean bottoms as contrasted to those which constitute the crust of the globe. Dr Carpenter[6] has also further developed this view of the great antiquity of the oceanic basins.

[1] Earth and Man, 1856.
[2] J. D. Dana, Manual of Geology, 1863, p. 732; Proc. Am. Ass. Adv. Science for 1873; Am. Journ. of Science, 1873.
[3] L. Agassiz, Nov. 1869, Bull. Mus. Comp. Zool., vol. i., No. 13.
[4] Geographical Evolution, 1879.
[5] John Murray, 1876, On Oceanic Deposits, Proc. Roy. Soc., No. 170.
[6] W. B. Carpenter, 1880, Lecture before the Royal Institution, January 23, 1880.

Littoral Species.

	Range in Depth. Fathoms.	Principal Localities.
DESMOSTICHA, Hæckel.		
Cidaridæ, Müller.		
Goniocidaridæ, Hæckel.		
Cidaris, Kl.		
C. metularia, Bl., ...	—	Cape of Good Hope; Red Sea; Mauritius; East India Islands; Sandwich Islands; Fiji Islands.
C. thouarsii, Val., ...	—	Panama; Gulf of California.
× *C. tribuloides*, Bl., ...	-250 B.	South Carolina; Florida; Brazil; Cape Palmas.
Dorocidaris, A. Ag.		
**D. bracteata*, A. Ag., . . .	15-100 C.	Amboyna.
× *D. papillata*, A. Ag., . . .	-874 B.	Shetland Islands; Norway; Mediterranean; Canary Islands; Florida; Caribbean Islands; St Paul's Rocks; La Plata; Philippines.
Phyllacanthus, Br.		
× *P. annulifera*, A. Ag., . . .	-28 C.	Australia; Philippine Islands; Torres Straits.
× *P. baculosa*, A. Ag., . . .	-102 C.	Red Sea; Zanzibar; Mauritius; Philippines.
P. dubia, Br., ...	—	Zanzibar; Bonin Islands; Australia.
× *P. gigantea*, A. Ag., . . .	—	Sandwich Islands.
P. imperialis, Br., ...	—	Red Sea; East India Islands; Australia.
× *P. verticillata*, A. Ag., . . .	-8 C.	Society Islands; East India Islands; Australia; Sandwich Islands; Torres Straits.
Stephanocidaris, A. Ag.		
S. bispinosa, A. Ag., . . .	—	Australia; Malacca.
Goniocidaris, Des.		
× *G. canaliculata*, A. Ag., . . .	-1975 C.	Falkland Islands; Patagonia; Natal; Zanzibar; Marion Islands to Kerguelen; Heard Islands; Kerguelen to Australia.
G. geranioides, Agass., . . .	—	Australia; East Indies; Tasmania.
× *G. tubaria*, Lütk., ...	-40 C.	Australia; Tasmania; New South Wales.
Arbaciadæ, Gray.		
Arbacia, Gray.		
A. australis, Trosch., . . .	—	Australia.
× *A. dufresnii*, Gray, . . .	-175 C.	Patagonia; Chili; Nightingale Island.
× *A. nigra*, A. Ag., ...	—	Patagonia; Chili; Peru; Philippines.
A. punctulata, Gray, . . .	-125 B.	Long Island Sound to West Florida; Yucatan.
× *A. pustulosa*, Gray, . . .	—	Mediterranean; Liberia; Brazil.
A. spatuligera, A. Ag., . . .	—	Chili; Peru.
A. stellata, Gray, ...	—	Panama; Gulf of California.
Diadematidæ, Peters.		
Diadema, Schynv.,		
D. mexicanum, A. Ag., . . .	—	Acapulco; Cape St Lucas.
× *D. setosum*, Gray, ...	-115 B.	Bermudas; West India Islands; Cape Verde Islands; Indian Ocean; Japan; Sandwich Islands; Fiji Islands; Philippines.
Centrostephanus, Pet.		
C. coronatus, A. Ag., . . .	—	Cape St Lucas.
C. longispinus, Pet., . . .	—	Palermo; Canary Islands.
C. rodgersii, A. Ag., . . .	—	Australia; New Caledonia.

	Range in Depth. Fathoms.	Principal Localities.
Echinothrix, Pet.		
× *E. calamaris*, A. Ag., ...	—	Society Islands; East India Islands; Philippine Islands; Kandavu Reef.
E. desorii, Pet., ...	—	Red Sea; Fiji Islands; Sandwich Islands.
× *E. turcarum*, Pet., ...	—	Sandwich Islands; Fiji Islands; Japan; East India Islands; Red Sea; Zanzibar; Kandavu Reef.
Astropyga, Gray.		
A. elastica, Stud., ...	[20	New Britain.
× *A. pulvinata*, Agass., ...	–49 C.	Panama; Gulf of California; Torres Straits; Honolulu.
A. radiata, Gray, ...	—	Zanzibar; East India Islands; Philippine Islands.
ECHINOTHURIDÆ, Wy. Thom.		
Asthenosoma, Grube.		
**A. grubii*, A. Ag., ...	[10 C.	Philippines.
A. varium, Grube., ...	—	China Seas.
ECHINOMETRADÆ, Gray.		
Colobocentrotus, Br.		
C. atratus, Br., ...	—	Zanzibar; Java; Sandwich Islands.
C. mertensii, Br., ...	—	Bonin Islands; Australia.
Heterocentrotus, Br.		
× *H. mammillatus*, Br., ...	—	Sandwich Islands; East India Islands; Red Sea; Fiji Islands; Kandavu Reef.
× *H. trigonarius*, Br., ...	—	Maritius; Java; Sandwich Islands; Fiji Islands; New Caledonia.
Echinometra, Rondel. (Breyn.)		
× *E. lucunter*, Bl., ...	–18 C.	Zanzibar; Red Sea; East India Islands; Japan; Sandwich Islands; Fiji Islands; Philippines; Kandavu Reef.
E. macrostoma, A. Ag., ...	—	West Coast, Africa.
E. oblonga, Bl., ...	—	Sandwich Islands; Philippine Islands; Seychelle Islands.
× *E. subangularis*, Desml., . . .	–250 B.	Senegal; Cape Verde; Brazil; West India Islands; Bermudas; Ascension.
E. van brunti, A. Ag., ...	—	Peru; Panama; Gulf of California.
E. viridis, A. Ag., ...	–7 B.	Florida; Hayti.
Parasalenia, A. Ag.		
P. gratiosa, A. Ag., ...	—	Kingsmills Islands; Bonin Islands; Zanzibar; Fiji Islands; New Caledonia.
Stomopneustes, Agass.		
S. variolaris, Agass., ...	—	Mauritius; Java; Samoa.
Strongylocentrotus, Br.		
S. albus, A. Ag., ...	—	Patagonia; Chili; Peru; Philippines.
S. armiger, A. Ag., ...	—	Australia.
S. depressus, A. Ag., ...	—	Japan.
× *S. dröbachiensis*, A. Ag., . . .	–78	North European; North Pacific; North-East Coast of America.
× *S. eurythrogrammus*, A. Ag., . . .	-35 C.	Australia; Tasmania; Samoa; New Caledonia; New South Wales.
S. franciscanus, A. Ag., . . .	—	Formosa; Puget Sound; San Diego; Japan.
S. gaimardi, A. Ag., ...	—	Brazil.
× *S. gibbosus*, A. Ag., ...	–45 C.	Chili; Galapagos; Peru; Fiji Islands; West Patagonia.
S. intermedius, A. Ag., ...	—	Japan; Australia.
S. lividus, Br., ...	—	European Atlantic; Mediterranean; Azores.
S. mexicanus, A. Ag., ...	—	Gulf of California.
S. nudus, A. Ag., ...	—	Sandwich Islands; Japan.
S. purpuratus, A. Ag., ...	—	San Francisco; Puget Sound.
S. tuberculatus, Br., ...	—	Japan; China; Australia; New Zealand; Galapagos.

	Range in Depth. Fathoms.	Principal Localities.
Sphærechinus, Des.		
× *S. australiæ*, A. Ag.,	-40 C.	Australia; Mauritius; New Zealand; New South Wales.
× *S. granularis*, A. Ag.,	-400 C.	Mediterranean; Canary Islands; West Coast, France; Azores; St Vincent.
S. pulcherrimus, A. Ag.,	—	Japan; China Seas.
Pseudoboletia, Trosch.		
P. granulata, A. Ag.,	—	Sandwich Islands.
× *P. indiana*, A. Ag.,	-10 C.	Philippine Islands; Mauritius.
Echinostrephus, A. Ag.		
E. molare, A. Ag.,	—	Society Islands; Zanzibar; Natal; Sandwich Islands; East India Islands.
ECHINIDÆ, Agass.		
TEMNOPLEURIDÆ, Des.		
Temnopleurus, Agass.		
× *T. hardwickii*, A. Ag.,	-129 C.	Japan; Kamtchatka; Philippines; Arafura Sea.
× *T. reynaudi*, Agass.,	-275 C.	Ceylon; China Seas; East India Islands; Philippines; New Zealand.
× *T. toreumaticus*, Agass.,	-20 C.	Gulf of Persia; Bombay; East India Islands; China; Philippines.
Pleurechinus, Agass.		
× *P. bothryoides*, Agass.,	—	Galapagos (?); Japan; Arafura Sea.
Microcyphus, Agass.		
M. maculatus, Agass.,	—	Japan; Navigator Islands; East India Islands.
× *M. zigzag*, Agass.,	-40 C	Japan; Philippine Islands; Tasmania; New South Wales.
Salmacis, Agass.		
× *S. bicolor*, Agass.,	-10 C	Red Sea; Mozambique; Bombay; Philippines.
× *S. dussumieri*, Agass.,	-100 C	China Seas; East India Islands; Philippines.
× *S. globator*, Agass.,	-8 C	Australia; Arafura Sea.
× *S. rarispina*, Agass.,	-28 C.	Philippine Islands; Siam; China Seas; Arafura Sea.
× *S. sulcata*, Agass.,	—	Australia; Philippine Islands; Mozambique; Red Sea.
Mespilia, Des.		
× *M. globulus*, Agass.,	-10 C.	Japan; Philippine Islands; Sandwich Islands.
Amblypneustes, Agass.		
× *A. formosus*, Val.,	-40 C.	Australia; New South Wales.
A. griseus, Agass.,	—	Australia; New Zealand.
A. ovum, Agass.,	—	Australia.
A. pallidus, Val.,	—	Australia; Fiji Islands.
A. pentagonus, A. Ag.,	—	Mauritius (?).
Holopneustes, Agass.		
H. inflatus, A. Ag.,	—	Australia.
H. porosissimus, Agass.,	—	Australia.
× *H. purpurescens*, A. Ag.,	-15 C.	Australia; New South Wales.
TRIPLECHINIDÆ, A. Ag.		
Phymosoma, Haime.		
P. crenulare, A. Ag.,	—	Japan.

	Range in Depth. Fathoms.	Principal Localities.
Echinus, Rond. (Linn.).		
× *E. acutus*, Lamk.,	–1350 C.	Norway; Shetland; Mediterranean; Halifax to New York; Ascension; Kermadec Islands.
E. albocinctus, Hutt.,	—	New Zealand.
× *E. angulosus*, A. Ag.,	—	Cape of Good Hope; Mauritius; Red Sea; Philippines; New Zealand; Australia.
E. darleyensis, Wood.,	—	Australia.
E. elevatus, Hutt.,	—	New Zealand.
E. esculentus, Linn.,	—	Norway; English Channel.
× *E. magellanicus*, Phil.,	–1600 C.	Patagonia; Chili; New Zealand; Australia; Cape of Good Hope to Marion Islands to Kerguelen; Falkland Islands.
× *E. margaritaceus*, Lamk.,	–245 C.	West Patagonia; Straits of Magellan; New Zealand; Kerguelen; Heard Islands.
E. melo, Lamk.,	–190.	Mediterranean; Canary Islands; Cape Verde Islands.
E. microtuberculatus, Bl.,	—	Mediterranean; Cape Verde Islands.
E. miliaris, Müll.,	—	Norway; English Channel.
Toxopneustes, Agass.		
T. maculatus, A. Ag.,	—	Christmas Islands; Bourbon.
× *T. pileolus*, Agass.,	–10 C.	Panama; East India Islands; Fiji Islands; Mauritius; New Caledonia; Sandwich Islands; Philippines.
T. semituberculatus, Agass.,	—	Galapagos; West Coast Central America; Cape St Lucas.
× *T. variegatus*, A. Ag.,	–242 B.	Bermudas; South Carolina; West India Islands; Brazil; Straits of Florida.
Hipponoë, Gray.		
H. depressa, A. Ag.,	—	Gulf of California.
H. esculenta, A. Ag.,	–451 B.	Florida; West Indies; Surinam; Bermudas; Yucatan.
× *H. variegata*, A. Ag.,	–15 C.	Sandwich Islands; Japan; East India Islands; Fiji Islands; Red Sea; Mozambique; Philippines; Kandavu Reef; New South Wales.
Evechinus, Verrill.		
× *E. chloroticus*, Verrill.,	—	New Zealand; Kandavu Reef.
CLYPEASTRIDÆ, Agass.		
EUCLYPEASTRIDÆ, Haeckel.		
FIBULARINA, Gray.		
Echinocyamus, Van Phels.		
× *E. pusillus*, Gray,	–805 B.	Norway; Iceland; Mediterranean; Azores; Florida; Caribbean Islands; North Brazil.
Fibularia, Lamk.		
× *F. australis*, Desml.,	–950 C.	Sandwich Islands; Japan; Australia; Kingsmills Islands; New South Wales.
F. ovulum, Lamk.,	—	Indian Ocean; Philippine Islands.
× *F. volva*, Agass.,	–28 C.	Red Sea; Formosa; North Australia.
ECHINANTHIDÆ, A. Ag.		
Clypeaster, Lamk.		
× *C. humilis*, A. Ag.,	–20 C.	Red Sea; East India Islands; New Caledonia; Philippines; Amboyna.
C. rotundus, A. Ag.,	—	Panama; San Diego.
× *C. scutiformis*, Lamk.,	—	Red Sea; Philippine Islands; Kingsmills Islands; Japan; New Caledonia.
× *C. subdepressus*, Agass.,	–120 B.	West Coast of Africa; Florida; South Carolina; Brazil; West India Islands.
Echinanthus, Breyn.		
E. rosaceus, Gray,	–118 B.	West India Islands; Florida; South Carolina.
× *E. testudinarius*, Gray,	–120 C.	Australia; Japan; Sandwich Islands; Gulf of California; New South Wales.

	Range in Depth. Fathoms.	Principal Localities.
LAGANIDÆ, Des. (emend.).		
Laganum, Kl.		
L. bonani, Kl.,	—	Tasmania; East India Islands; Philippine Islands.
× *L. depressum*, Less.,	—	Kingsmills Islands; Fiji Islands; Philippine Islands; Australia; Zanzibar; Arafura Sea.
× *L. putnami*, Barn.,	-25 C.	Japan; Amboyna.
Peronella, Gray.		
× *P. decagonalis*, A. Ag.,	-315 C.	Japan; New Caledonia; Bay of Bengal; East India Islands; Philippines; Arafura Sea; Tonga; Tahiti.
P. orbicularis, A. Ag.,	—	Australia; Formosa.
× *P. peronii*, Gray,	-40 C.	Tasmania; Philippine Islands; New South Wales.
P. rostrata, A. Ag.,	—	New Zealand; Zanzibar.
SCUTELLIDÆ, Agass.		
Echinarachnius, Leske.		
E. excentricus, Val.,	—	California; Alaska; Kamtchatka.
E. mirabilis, A. Ag.,	—	Japan; Aleutian Islands.
E. parma, Gray,	-306 B.	New Jersey; Labrador; Vancouver Island; Kamtchatka; Aleutian Islands; Japan; Australia; India; Red Sea.
Arachnoides, Kl.		
A. placenta, Agass.,	—	New Zealand; Australia; East India Islands; Burmah.
Echinodiscus, Breyn.		
E. auritus, Leske.,	—	Zanzibar; Philippine Islands.
E. biforis, A. Ag.,	—	Mozambique; Red Sea; Java; Cape of Good Hope.
× *E. lævis*, A. Ag.,	—	Japan; New Caledonia; East India Islands; South Africa.
Mellita, Kl.		
M. erythræa, Gray,	—	Red Sea (?).
M. longifissa, Mich.,	—	Panama; Gulf of California.
M. pacifica, Verrill.,	—	Peru.
× *M. sexforis*, A. Ag.,	-270 B.	Brazil; West India Islands; South Carolina; Bermudas.
M. stokesii, A. Ag.,	—	Guayaquil; Panama; Galapagos.
M. testudinata, Kl.,	-7 B.	Brazil; West India Islands; North and South Carolina; Nantucket.
Astriclypeus, Verrill.		
× *A. manni*, Verrill.,	—	China; Japan.
Rotula, Kl.		
R. augusti, Kl.,	—	Liberia; Senegal; Cape Verde Islands.
R. rumphii, Kl.,	—	Senegal; Cape Verde Islands.
Encope, Agass.		
E. californica, Verrill.,	—	Gulf of California.
× *E. emarginata*, Agass.,	-70 C.	Brazil; West Indies; Yucatan; Florida; South Carolina.
E. grandis, Agass.,	—	Gulf of California.
E. michelini, Agass.,	-11 B.	Yucatan; Florida.
E. micropora, Agass.,	—	Panama; Gulf of California.
PETALOSTICHA, Hæckel.		
CASSIDULIDÆ, Agass.		
ECHINONIDÆ, Agass.		
Echinonëus, Van Phel.		
E. cyclostomus, Leske.,	—	Australia; Kingsmills Islands; Zanzibar; East India Islands.
E. semilunaris, Lamk.,	—	Florida; West India Islands

	Range in Depth. Fathoms.	Principal Localities.
NUCLEOLIDÆ, Agass.		
Echinolampas, Gray.		
E. alexandri, Lor.,	—	Mauritius.
E. depressa, Gray,	–160 B.	Straits of Florida; Caribbean Islands.
E. hellei, Val.,	—	Senegal.
× *E. oviformis*, Gray,	–129 C.	Red Sea; Molucca; Cape of Good Hope; Mauritius; Indian Archipelago.
Rhynchopygus, D'Orbig.		
R. caribæarum, Lütk.,	–106 B.	West India Islands.
R. pacificus, A. Ag.,	—	Galapagos; Panama; Gulf of California.
Echinobrissus, Breyn.		
E. recens, D'Orb.,	—	New Zealand; Madagascar.
Nucleolites, Lamk.		
N. epigonus, Mart.,	—	East India Islands.
Anochanus, Grube.		
A. sinensis, Grube,	—	East India Islands.
SPATANGIDÆ, Agass.		
ANANCHYTIDÆ, Alb. Gras.		
Paleopneustes, A. Ag.		
P. hystrix, A. Ag.,	21–208 B.	Caribbean Islands.
Platybrissus, Grube.		
P. roemeri, Grube,	—	
SPATANGINA, Gray.		
Spatangus, Kl.		
S. lütkeni, A. Ag.,	—	Japan.
× *S. purpureus*, Leske,	–450 B. C.	Norway; Shetland Islands; Mediterranean; Caribbean Islands; Bermudas; Azores.
Maretia, Gray.		
× *M. alta*, A. Ag.,	–800 C.	Japan; Luzon; Arafura Sea.
M. elliptica, Bol.,	—	South Sea.
× *M. planulata*, Gray,	–25 C.	Kingsmills Islands; China; East India Islands; New Caledonia; Mauritius; Australia; Levuka Reef.
Eupatagus, Agass.		
× *E. valenciennesii*, Agass.,	—	Australia; Arafura Sea; New South Wales.
Lovenia, Des.		
L. cordiformis, Lütk.,	—	Guyaquil; Gulf of California.
× *L. elongata*, Gray,	–28 C.	Red Sea; Australia; Philippine Islands; Arafura Sea; Cape of Good Hope.
× *L. subcarinata*, Gray.	–10 C.	China; Luzon; Japan; Sandwich Islands.
Breynia, Des.		
× *B. australasiæ*, Gray,	—	Red Sea; Australia; Japan; Sandwich Islands; Torres Straits.
Echinocardium, Gray.		
× *E. australe*, Gray,	–2675 C.	New Zealand; Australia; New South Wales; Van Diemen's Land; Japan; East India; Cape of Good Hope; Mozambique.
E. cordatum, Gray,	–85 B.	Norway; Shetland Islands; Mediterranean; Brazil; Florida; North Carolina.
× *E. flavescens*, A. Ag.,	–150 B.	Norway; Shetland Islands; Cape of Good Hope; South Carolina; Florida.
E. mediterraneum, Gray,	—	Mediterranean.

	Range in Depth. Fathoms.	Principal Localities.
LESKIADÆ, Gray.		
Palæostoma, Lovén.		
P. mirabilis, Lov.,	—	China; East India Islands.
BRISSINA, Gray.		
Hemiaster, Des.		
× *H. cavernosus*, A. Ag.,	–400 C.	Patagonia; Chili; La Plata River; Straits of Magellan; Kerguelen; Heard Islands.
Tripylus, Phil.		
T. excavatus, Phil.,	—	Patagonia; Chili.
Rhinobrissus, A. Ag.		
**R. hemiasteroides*, A. Ag.,	[20 C.	Tahiti.
R. pyramidalis, A. Ag.,	—	China.
Brissopsis, Agass.		
× *B. luzonica*, A. Ag.,	–1100 C.	Luzon; Siam; New Caledonia; Tahiti; Philippines; Arafura Sea; Japan; New Zealand.
× *B. lyrifera*, Agass.,	–2135 P.	Norway; Mediterranean; Florida; Greenland; Cape of Good Hope; Caribbean Islands.
Agassizia, Val.		
A. scrobiculata, Val.,	—	Peru; Panama; Gulf of California.
Brissus, Kl.		
B. carinatus, Gray,	—	Society Islands; Sandwich Islands; East Indies; Mauritius; Philippine Islands.
B. obesus, Verrill,	—	Panama; Gulf of California.
B. unicolor, Kl.,	–7 B.	West India Islands; Cape Verde Islands; Mediterranean.
Metalia, Gray.		
M. africana, A. Ag.,	—	Sherboro Islands
M. costæ, Lud.,	–25.	Mediterranean; Capri.
× *M. maculosa*, A. Ag.,	–28 C.	Samoa; Sandwich Islands; Australia; Mauritius; Panama; Arafura Sea; Gulf of California.
× *M. pectoralis*, A. Ag.,	–156 B.	West India Islands; Florida; Brazil.
M. sternalis, Gray,	—	Sandwich Islands; Society Islands; East India Islands; Philippine Islands; Australia; North Caledonia; Red Sea.
Meoma, Gray.		
M. grandis, Gray,	—	Acapulco; Gulf of California.
M. ventricosa, Lütk.,	–242 B.	West India Islands; Straits of Florida.
Linthia, Mer.		
L. australis, A. Ag.,	—	Tasmania.
L. rostrata, Smith,	—	Pacific Islands.
Faorina, Gray.		
F. chinensis, Gray,	—	China; Sandwich Islands.
Schizaster, Agass.		
S. canaliferus, Agass.,	–37	Mediterranean.
S. gibberulus, Agass.,	—	Red Sea.
**S. japonicus*, A. Ag.,	–8–50 C.	Off Japan; China; Arafura Sea.
S. philippii, A. Ag.,	—	Patagonia.
× *S. ventricosus*, Gray.	–345 C.	Fiji Islands; Philippines; Siam; Japan.
Moira, A. Ag.		
M. atropos, A. Ag.,	–60 B.	West Indies; North and South Carolina; Straits of Florida.
M. clotho, A. Ag.,	—	Gulf of California.
M. stygia, A. Ag.,	—	Red Sea (?); Zanzibar (?).

An examination of the table of Littoral species[1] shows us a few species such as—

Dorocidaris papillata.
Goniocidaris canaliculata.
Sphærechinus granularis.
Echinus acutus.
Echinus magellanicus.
Echinocyamus pusillus.
Fibularia australis.
Spatangus purpureus.
Maretia alta.
Echinocardium australe.
Hemiaster cavernosus.
Brissopsis lyrifera.
Brissopsis luzonica.

which have an extensive bathymetrical range, in some cases even an extraordinary one; the geographical range of the greater number of these species is at the same time very extended. But out of the great number of the species I have called littoral, in spite of the great bathymetrical extension of some of them, we find that of the two hundred and ninety-seven known species two hundred and one are enumerated as littoral, distributed among the following families and genera:—

CIDARIDÆ (15 species).
Cidaris, 3.
Dorocidaris, 2.
Phyllacanthus 6.
Stephanocidaris, 1.
Goniocidaris, 3.

ARBACIADÆ (7 species).
Arbacia, 7.

DIADEMATIDÆ (11 species).
Diadema, 2.
Centrostephanus, 3.
Echinothrix, 3.
Astropyga, 3.

ECHINOTHURIDÆ (2 species).
Asthenosoma, 2.

ECHINOMETRADÆ (32 species).
Colobocentrotus, 2.
Heterocentrotus, 2.
Echinometra, 6.
Parasalenia, 1.
Stomopneustes, 1.
Strongylocentrotus, 14.
Sphærechinus, 3.
Pseudoboletia, 2.
Echinostrephus, 1.

TEMNOPLEURIDÆ (20 species).
Temnopleurus, 3.
Pleurechinus, 1.
Microcyphus, 2.
Salmacis, 5.
Mespilia, 1.
Amblypneustes, 5.
Holopneustes, 3.

TRIPLECHINIDÆ (20 species).
Phymosoma, 1.
Echinus, 11.
Toxopneustes, 4.
Hipponoë, 3.
Evechinus, 1.

[1] There are, of course, associated as littoral, species which in some geographical districts do not extend upwards beyond the Continental limits; the exact bathymetrical range is given in the lists of the geographical districts as far as it could be stated.

Or thirty-two genera of Desmosticha, representing one hundred and seven species.

FIBULARINA (4 species).
Echinocyamus, 1.
Fibularia, 3.

ECHINANTHIDÆ (6 species).
Clypeaster, 4.
Echinanthus, 2.

LAGANIDÆ (7 species).
Laganum, 3.
Peronella, 4.

SCUTELLIDÆ (21 species).
Echinarachnius, 3.
Arachnoides, 1.
Echinodiscus, 3.
Mellita, 6
Astriclypeus, 1.
Rotula, 2.
Encope, 5

Or thirteen genera of Clypeastridæ, represented by thirty-eight species.

ECHINONEIDÆ (2 species).
Echinoneus, 2.

NUCLEOLIDÆ (9 species).
Echinolampas, 4.
Rhynchopygus, 2.
Echinobrissus, 1.
Nucleolites, 1.
Anochanus, 1.

ANANCHYTIDÆ (2 species).
Paleopneustes, 1.
Platybrissus, 1.

SPATANGINA (14 species).
Spatangus, 2.
Maretia, 3.
Eupatagus, 1.
Lovenia, 3.
Breynia, 1.
Echinocardium, 4.

LESKIADÆ (1 species).
Paleostoma, 1.

BRISSINA (28 species).
Hemiaster, 1.
Tripylus, 1.
Rhinobrissus, 2.
Brissopsis, 2.
Agassizia, 1.
Brissus, 3.
Metalia, 5.
Meoma, 2.
Linthia, 2.
Faorina, 1.
Schizaster, 5.
Moira, 3.

Or twenty-seven genera of the Petalosticha represented by fifty-six species.

These two hundred and one species give us from their geographical distribution the characteristic littoral faunæ, and from the comparison of which I had been led, in the Revision of the Echini (p. 212), to subdivide the recent Echinid faunæ into the following great realms:—Atlantic, Circumpolar, Australian, Antarctic, Pacific, and American. These subdivisions, of course, have partially lost their significance as will be seen in the discussion of the geographical lists which follow.

Continental Species.

	Range in Depth. Fathoms.	Principal Localities.
DESMOSTICHA, Hæckel.		
Cidaridæ, Müll.		
Goniocidaridæ, Hæckel.		
Dorocidaris, A. Ag.		
**D. blakii*, A. Ag.,	158–450 B.	Florida; Caribbean Islands.
D. bartletti, A. Ag.,	76–398 B.	Caribbean Islands.
Porocidaris, Des.		
P. sharreri, A. Ag.,	123–351 B.	Caribbean Islands.
Goniocidaris, Des.		
**G. florigera*, A. Ag.,	100–129 C.	Philippines; Indian Archipelago.
Salenidæ, Agass.		
Salenia, Gray.		
S. gœsiana, Lov.,	[180 J.	West India Islands.
**S. hastigera*, A. Ag.,	100–1850 C.	Philippines; Kermadec; Indian Archipelago; Azores.
S. pattersoni, A. Ag.,	175–450 B.	Caribbean Islands.
× *S. varispina*, A. Ag.,	60–1675 B. C.	Florida; Caribbean Islands; North Brazil; Ascension; Azores; Canary Islands.
Arbaciadæ, Gray.		
Podocidaris, A. Ag.		
× *P. sculpta*, A. Ag.,	138–390 B.	Florida; Caribbean Islands.
Cœlopleurus, Agass.		
C. floridanus, A. Ag.,	56–1323 B.	Florida; Caribbean Islands.
× *C. maillardi*, A. Ag.,	82–102 C.	Bourbon; Philippines; Amboyna; Indian Archipelago.
Diadematidæ, Peters.		
Aspidodiadema, A. Ag.		
**A. tonsum*, A. Ag.,	100–1700 C.	Philippines; Kermadec; Macio.
A. jacobyi, A. Ag.,	95–287 B.	Caribbean Islands.
Micropyga, A. Ag.		
**M. tuberculatum*, A. Ag.,	100–610 C.	Philippines; Fiji Islands.
Echinothuridæ, Wy. Thom.		
Asthenosoma, Grube.		
**A. gracile*, A. Ag.,	150–255 C.	Philippines; New Zealand.
A. hystrix, A. Ag.,	100–445 B. P.	Florida; North East Atlantic; Caribbean Islands.
**A. pellucidum*, A. Ag.,	100–129 C.	Philippines; Indian Archipelago.
**A. tessellatum*, A. Ag.,	100–115 C.	Philippines.
A. reynoldsii, A. Ag.,	180–375 B.	Caribbean Islands.
Phormosoma, Wy. Thom.		
P. sigsbei, A. Ag.,	120–1250 B.	Caribbean Islands.
Echinidæ, Agass.		
Temnopleuridæ, Des.		
Temnechinus, Forbes.		
T. maculatus, A. Ag.,	30–600 B. J.	Florida; Caribbean Islands; Josephine Bank.
Trigonocidaris, A. Ag.		
T. albida, A. Ag.,	60–450 B.	Florida; Caribbean Islands; Josephine Bank.
Triplechinidæ, A. Ag.		
Hemipedina, Wright.		
H. cubensis, A. Ag.,	138–270 B.	Straits of Florida.

	Range in Depth. Fathoms.	Principal Localities.
Echinus, Rond. (Linn.)		
× *E. elegans*, Düb. o. Kor.,	80–1350 C.	Norway; Mediterranean; Tristan da Cunha; New York; Papua.
E. gracilis, A. Ag.,	93–200 B.	Florida; West India Islands.
**E. horridus*, A. Ag.,	[175 C.	Straits of Magellan; West Patagonia.
E. microstoma, Wy. Thom.,	150–450 P.	West Coast of Scotland and Ireland.
× *E. norvegicus*, Düb. o. Kor.,	80–2435 B. P.	Norway; Mediterranean; Japan; West Patagonia.
E. wallisii, A. Ag.,	257–1047 B.	Atlantic Coast of U.S. (Southern and Middle States).
PETALOSTICHA, Hæckel.		
CASSIDULIDÆ, Agass.		
NUCLEOLIDÆ, Agass.		
Neolampas, A. Ag.		
N. rostellata, A. Ag.,	100–690 B. P.	Florida; Caribbean Islands; North-East Atlantic.
Conoclypus, Agass.		
C. sigsbii, A. Ag.,	84–450 B.	Straits of Florida; Yucatan.
Catopygus, Agass.		
**C. recens*, A. Ag.,	[129 C.	Indian Archipelago.
SPATANGIDÆ, Agass.		
ANANCHYTIDÆ, Alb. Gras.		
Palæotropus, Lov.		
P. josephinæ, Lov.,	82–250 B. J.	Caribbean Islands; Azores.
Linopneustes, A. Ag.		
L. longispinus, A. Ag.,	28–373 B.	Caribbean Islands.
Paleopneustes, A. Ag.		
P. cristatus, A. Ag.,	56–450 B.	Florida; Caribbean Islands.
SPATANGINA, Gray.		
Spatangus, Kl.		
× *S. raschi*, Lovén,	150–300 P. C.	German Ocean; Azores; Shetland Islands; Cape of Good Hope.
Nacopatagus, A. Ag.		
N. gracilis, A. Ag.,	[65 B.	Juan Fernandez.
Echinocardium, Gray.		
E. pennatifidum, Norm.,	79–121 B.	Northumberland; Shetland Islands; Florida.
BRISSINA, Gray.		
Rhinobrissus, A. Ag.		
R. micrasteroides, A. Ag.,	175–242 B.	Caribbean Islands.
Agassizia, Val.		
A. excentrica, A. Ag.,	46–391 B.	Florida; Caribbean Islands.
Brissus, Kl.		
**B. damesi*, A. Ag.,	120–450 C.	North Brazil; Azores.
Schizaster, Agass.		
× *S. fragilis*, Agass.,	71–955 B.	Norway; Gulf of St Lawrence; Florida; Caribbean Islands; Gulf of Maine; Cape of Good Hope.
**S. moseleyi*, A. Ag.,	40–1375 C.	Marion Islands; Kerguelen; West Patagonia; Straits of Magellan.
S. orbignyanus, A. Ag.,	92–1557 B.	Caribbean Islands.
Periaster, D'Orb.	28–118 B. C.	Gulf of Mexico; Arafura Sea.
× *P. limicola*, A. Ag.,		
Moiropsis, A. Ag.		
**M. claudicans*, A. Ag.,	[129 C.	Indian Archipelago.

The following species are also found within the continental limits. They are either littoral species (L.+) which extend beyond the ordinary range of the littoral species into the continental limits, or they are littoral species (L.++) which extend not only into the continental limits, but also into the limits of the abyssal fauna; some of the species extending nearly to the greatest depth at which Echinids have been collected.

	Range in Depth. Fathoms.	Principal Localities.
DESMOSTICHA, Hæckel.		
CIDARIDÆ, Müll.		
GONIOCIDARIDÆ, Hæckel.		
Cidaris, Kl.		
L. +× *C. tribuloides*, Bl.,	–250 B.	South Carolina; West India Islands; Cape Palmas.
Dorocidaris, A. Ag.		
L +* *D. bracteata*, A. Ag.,	–100 C.	Amboyna.
L.++×*D. papillata*, A. Ag.,	–874 B.	Norway; Philippines; South Atlantic.
Goniocidaris, Des.		
L.++×*G. canaliculata*, A. Ag.	–1975 C.	Patagonia; Zanzibar; Australia; Southern Ocean.
ARBACIDÆ, Gray.		
Arbacia, Gray.		
L.+× *A. dufresnii*, Gray,	–175 C.	Patagonia; Chili.
L.× *A. punctulata*, Gray,	–125 B.	Long Island Sound; Yucatan.
ECHINOMETRADÆ, Gray.		
Echinometra, Rondel. (Breyn.).		
L. +× *E. subangularis*, Desml.,	–250 B.	Senegal; West India Islands; Ascension Island.
Sphærechinus, Des.		
L. +× *S. granularis*, A. Ag.,	–400 C.	Mediterranean; St Vincent.
ECHINIDÆ, Agass.		
TEMNOPLEURIDÆ, Des.		
Temnopleurus, Agass.		
L. +× *T. hardwickii*, A. Ag.,	–129 C.	Japan; Arafura Sea.
L. +× *T. reynaudi*, Agass.,	–275 C.	Ceylon; East India Islands; New Zealand.
Salmacis, Agass.		
L. +× *S. dussumieri*, Agass.,	–100 C.	China Seas; East India Islands.
TRIPLECHINIDÆ, A. Ag.		
Echinus, Rond. (Linn.)		
L.++×*E. acutus*, Lamk.,	–1350 C.	Norway; Ascension Island.
L.++×*E. magellanicus*, Phil.,	–1600 C.	Patagonia; Cape of Good Hope; Australia.
L. +× *E. margaritaceus*, Lam.,	–245 C.	Patagonia; New Zealand: Heard Island.
L.+*E. melo*, Lam.,	–190	Mediterranean Cape Verde Islands.
Toxopneustes, Agass.		
L. +× *T. variegatus*, A. Ag.,	–300 B.	Bermudas; West India Islands; Brazil.
Hipponoë, Gray.		
L.+*H. esculenta*, A. Ag.,	–451 B.	West India Islands.

	Range in Depth. Fathoms.	Principal Localities.
CLYPEASTRIDÆ, Agass.		
EUCLYPEASTRIDÆ, Hæckel.		
FIBULARINA, Gray.		
Echinocyamus, Van Phelps.		
L.++× *E. pusillus*, Gray, . .	-805 B. C.	Norway; Azores; Florida; Brazil.
Fibularia, Lamk.		
L.++× *F. australis*, Desml., . .	-950 C.	Japan; Sandwich Islands; New South Wales.
ECHINANTHIDÆ, A. Ag.		
Clypeaster, Lamk.		
L.+× *C. subdepressus*, Agass., .	-120 B.	West Coast of Africa; Caribbean Islands.
Echinanthus, Breyn.		
L.+ *E. rosaceus*, Gray, . .	-118 B.	West India Islands; South Carolina.
L.+× *E. testudinarius*, Gray, .	-120 C.	Australia; Japan; Gulf of California.
LAGANIDÆ, Des. (emend.)		
Peronella, Gray.		
L.+× *P. decagonalis*, A. Ag., . .	-315 C.	Japan; East India Islands; New Caledonia; Tonga.
SCUTELLIDÆ, Agass.		
Echinarachnius, Gray, . . .		
L.+ *E. parma*, Gray, . . .	-306 B.	East Coast U.S.; Labrador; Red Sea; Australia; Japan; Kamtchatka; Aleutian Islands.
Mellita, Kl.		
L+ *M. sexforis*, A. Ag., . .	-270 B.	Brazil; West India Islands; South Carolina.
PETALOSTICHA, Hæckel.		
CASSIDULIDÆ, Agass.		
NUCLEOLIDÆ, Agass.		
Echinolampas, Gray.		
L.+ *E. depressa*, Gray, . .	-160 B.	Caribbean Islands.
L.+× *E. oviformis*, Gray, . . .	-129 C.	Red Sea; Cape of Good Hope; Indian Archipelago.
SPATANGIDÆ, Agass.		
SPATANGINA, Gray.		
Spatangus, Kl.		
L.+× *S. purpureus*, Leske, . .	-450 B. C.	Norway; Mediterranean; Caribbean Islands.
Maretia, Gray.		
L.++× *M. alta*, A. Ag. . . .	-800 C.	Japan; Luzon; Arafura Sea.
Echinocardium, Gray.		
L.++× *E. australe*, Gray, . .	-2675 C.	New Zealand; Australia; Mozambique.
L. +× *E. flavescens*, A. Ag., . .	-150 B.	Norway; Cape of Good Hope; Florida.
BRISSINA, Gray.		
Hemiaster, Des.		
L.+× *H. cavernosus*, A. Ag., . .	-400 C.	Patagonia; Chili; Kerguelen.
Brissopsis, Agass.		
L.++× *B. luzonica*, A. Ag., . .	-1100 C.	Luzon; Siam; New Caledonia; Japan; New Zealand.
L.++× *B. lyrifera*, Agass., . .	-2435 P.	Norway; Caribbean Islands; Cape of Good Hope.
Metalia, Gray.		
L. +× *M. pectoralis*, A. Ag., . .	-156 B.	West India Islands; Brazil.
Meoma, Gray.		
L.+ *M. ventricosa*, Lütk. . .	-242 B.	West India Islands; Straits of Florida.
Schizaster, Agass.		
L. +× *S. ventricosus*, Gray, . .	-345 C.	Fiji Islands; Philippines; Siam; Japan.

The preceding table gives us the range of a group of species of which, while many of them extend towards the littoral area, the upper limit is usually near the 100 fathom line, and we find here a proportionally larger number of species extending into deep water, into the next bathymetrical subdivision, than in the littoral species. The usual limit of the continental species in depth is from 350 to 450 fathoms. There are forty-six continental species of which ten extend to great depths. The species which have an exceptionally great bathymetrical range are—*Salenia hastigera* and *Salenia varispina*, *Cœlopleurus floridanus*, *Aspidodiadema tonsum*, *Phormosoma sigsbei*, *Echinus elegans*, *Echinus norvegicus*, *Schizaster fragilis*, *Schizaster moseleyi*, and *Schizaster orbignyanus*.

The continental species are distributed as follows, excepting, of course, the few species which extend beyond the usual littoral limit downwards, and the species of this group which reach upwards from the abyssal district, and thus produce a bathymetrical mixture similar to the mixture we might obtain of successive geological horizons:—

CIDARIDÆ (4 species).
- *Dorocidaris*, 2.
- *Porocidaris*, 1.
- *Goniocidaris*, 1.

SALENIDÆ (4 species).
- *Salenia*, 4.

ARBACIADÆ (3 species).
- *Podocidaris*, 1.
- *Cœlopleurus*, 2.

DIADEMATIDÆ (3 species).
- *Aspidodiadema*, 2.
- *Micropyga*, 1.

ECHINOTHURIDÆ (6 species).
- *Asthenosoma*, 5.
- *Phormosoma*, 1.

TEMNOPLEURIDÆ (2 species).
- *Temnechinus*, 1.
- *Trigonocidaris*, 1.

TRIPLECHINIDÆ (7 species).
- *Hemipedina*, 1.
- *Echinus*, 6.

Or twenty-nine species of Desmosticha distributed among fourteen genera. The Clypeastridæ have entirely disappeared.

Among the Petalosticha there are seventeen species distributed among the following fifteen genera.

NUCLEOLIDÆ (3 species).
- *Neolampas*, 1.
- *Conoclypus*, 1.
- *Catopygus*, 1.

ANANCHYTIDÆ (3 species).
- *Palæotropus*, 1.
- *Linopneustes*, 1.
- *Paleopneustes*, 1.

SPATANGINA (3 species).
- *Spatangus*, 1.
- *Nacopatagus*, 1.
- *Echinocardium*, 1.

Brissina (8 species).

Rhinobrissus, 1.	*Schizaster*, 3.
Agassizia, 1.	*Periaster*, 1.
Brissus, 1.	*Moiropsis*, 1.

Among these continental species there are already quite a number of the deep-sea genera, or of genera characterised by their ancient geological facies. Those which appear are—

Salenia.	*Catopygus.*
Porocidaris.	*Conoclypus.*
Cœlopleurus.	*Neolampas.*
Phormosoma.	*Palæotropus.*
Asthenosoma.	*Linopneustes.*
Temnechinus.	*Paleopneustes.*
Trigonocidaris.	*Periaster.*

The analysis of the supplementary continental table shows us that the forty-six species of the truly continental fauna are associated below the 100 fathom line with no less than thirty-seven littoral species, eleven of which even extend beyond the usual limits of the continental species far into the oceanic fauna—

Abyssal or Oceanic Species.

	Range in Depth. Fathoms.	Principal Localities.
DESMOSTICHA, Hæckel.		
Cidaridæ, Müll.		
Goniocidaridæ, Hæckel.		
Porocidaris, Des.		
**P. elegans*, A. Ag.,	410–500 C.	Philippines; Papua; New South Wales.
P. purpurata, Wy. Thom.,	[542 P.	Rockall.
Arbaciadæ, Gray.		
Podocidaris, A. Ag.		
**P. prionigera*, A. Ag.,	1050–1075 C.	Philippines; New Guinea.
P. scutata, A. Ag.,	[580 B.	Caribbean Islands.
Diadematidæ, Peters.		
Aspidodiadema, A. Ag.		
**A. microtuberculatum*, A. Ag.,	804–2225 B.C.	Macio; Caribbean Islands; Brazil; Tristan da Cunha; Chili; Juan Fernandez.
A. antillarum, A. Ag.,	451–1200 B.	Caribbean Islands.
Echinothuridæ, Wy. Thom.		
Asthenosoma, Grube.		
**A. coriaceum*, A. Ag.,	240–315 C.	Fiji Islands.
A. fenestratum, Wy. Thom.,	[445 (?) P.	Rockall; Bay of Biscay; West Coast of Portugal.

	Range in Depth. Fathoms.	Principal Localities.
Phormosoma, Wy. Thom.		
**P. asterias*, A. Ag.,	[2160 C.	Juan Fernandez to Chili.
**P. bursaria*, A. Ag.,	255–1050 C.	Japan; Philippines.
**P. hoplacantha*, Wy. Thom.,	410–1375 C.	Japan; New South Wales; Juan Fernandez to Chili.
**P. luculentum*, A. Ag.,	255–1050 C.	Philippines; Indian Archipelago.
P. placenta, Wy. Thom.,	500–800 P.	West Coast of Scotland and Ireland.
**P. rigidum*, A. Ag.,	700–1400 C.	New South Wales.
**P. tenue*, A. Ag.,	1875–2750 C.	Sandwich Islands to Low Archipelago; Japan.
**P. uranus*, Wy. Thom.,	1000–1525 C.	South Portugal; Azores.
P. petersii, A. Ag.,	399–1224 B.	Caribbean; Atlantic Coast of U.S. (Middle and Southern States).
ECHINIDÆ, Agass.		
TEMNOPLEURIDÆ, Des.		
Prionechinus, A. Ag.		
**P. sagittiger*, A. Ag.,	700–1070 C.	Philippines; New South Wales.
Cottaldia, Des.		
**C. forbesiana*, A. Ag.,	310–315 C.	Fiji Islands.
Trigonocidaris, A. Ag.		
**T. monolini*, A. Ag.,	[520 C.	Kermadec Islands.
CLYPEASTRIDÆ, Agass.		
ECHINOCONIDÆ, D'Orb.		
Pygaster, Agass.		
P. relictus, Lov.,	[180 J.	West India Islands.
PETALOSTICHA, Hæckel.		
SPATANGIDÆ, Agass.		
POURTALESIÆ, A. Ag.		
Pourtalesia, A. Ag.		
**P. carinata*, A. Ag.,	1950–2225 C.	Heard Islands to Antarctic; Juan Fernandez to Chili.
**P. ceratopyga*, A. Ag.,	1950–2225 C.	Heard Islands; Australia; Juan Fernandez to Chili; Antarctic.
**P. hispida*, A. Ag.,	1600–1975 C.	Marion Islands to Australia.
P. jeffreysi, Wy. Thom.,	[690 P.	Faroe Islands; Shetland Islands.
**P. laguncula*, A. Ag.,	345–2900 C.	Japan to Sandwich Islands; Arafura Sea; New Zealand.
P. miranda, A. Ag.,	242–1215 B.P.	Florida; Caribbean Islands; Shetland Islands.
P. phiale, Wy. Thom.,	1215–1975 P. C. Val.	Kerguelen to Australia; Rockall; North Atlantic.
**P. rosea*, A. Ag.,	[2600 C.	Sandwich Islands to Low Archipelago.
Spatagocystis, A. Ag.		
**S. challengeri*, A. Ag.,	1600–1950 C.	Antarctic to Australia.
Echinocrepis, A. Ag.		
**E. cuneata*, A. Ag.,	[1600 C.	Antarctic to Australia.
Urechinus, A. Ag.		
**U. naresianus*, A. Ag.,	1200–1800 B. C.	Antarctic to Australia; Juan Fernandez to Chili; Caribbean Islands.
Cystechinus, A. Ag.		
**C. clypeatus*, A. Ag.,	1050–1915 C.	Philippines; Tristan da Cunha to Bahia to Buenos Ayres.
**C. vesica*, A. Ag.,	1675–2225 C.	Antarctic; Kerguelen to Australia; Juan Fernandez to Chili.
**C. wyvillii*, A. Ag.,	1375–1825 C.	Antarctic; Kerguelen to Australia; Juan Fernandez to Chili.
Calymne, Wy. Thom.		
**C. relicta*, Wy. Thom.,	620–2650 C.	Azores.

	Range in Depth. Fathoms.	Principal Localities.
ANANCHYTIDÆ, Alb. Gras.		
Palæotropus, Lovén.		
**P. lovéni*, A. Ag.,	[375 C.	Philippines.
P. thomsoni, A. Ag.,	[233 B.	Caribbean Islands.
Argopatagus, A. Ag.		
**A. vitreus*, A. Ag.,	[800 C.	Arafura Sea.
Genicopatagus, A. Ag.		
**G. affinis*, A. Ag.,	[1950 C.	Antarctic; Kerguelen to Australia.
Homolampas, A. Ag.,		
× *H. fragilis*, A. Ag.,	300–1920 B.	Straits of Florida; Brazil; Josephine Bank.
**H. fulva*, A. Ag.,	2425–2475 C.	Sandwich Islands to Low Archipelago.
Linopneustes, A. Ag.		
**L. murrayi*, A. Ag.,	345–375 C.	Philippines; Japan.
BRISSINA, Gray.		
Hemiaster, Des.		
H. expergitus, Lov.,	464–485 B. J.	Caribbean Islands; East Atlantic; West Coast of Spain.
**H. gibbosus*, A. Ag.,	345–800 C.	Japan; Arafura Sea.
**H. zonatus*, A. Ag.,	620–750 C.	Bahia; Canary Islands.
H. mentzii, A. Ag.,	170–576 B.	Caribbean Islands.
Cionobrissus, A. Ag.		
**C. revinctus*, A. Ag.,	[800 C.	Arafura Sea.
Aërope, Wy. Thom.		
**A. rostrata*, Wy. Thom.,	800–1750 C. Val.	Arafura Sea; Bay of Biscay; Davis Straits.
Aceste, Wy. Thom.		
**A. bellidifera*, Wy. Thom.,	[2600 C.	Sandwich Islands to Low Archipelago; Buenos Ayres to Tristan da Cunha; Canary Islands.

When we come to the strictly deep-sea species, we find that many of them encroach at their upper limit into the lower limit of the continental species. Only a comparatively small number of species can be called abyssal, the lower limit of these not being, however, any greater than that of many of the species which have a higher continental limit.

There are fifty deep-sea species, of which twenty-seven either approach or encroach upon the lower limits of the continental species. Of these forty-six there are twelve which extend to a greater depth than 2000 fathoms, 2900 fathoms being the greatest depth at which any Sea-urchin has been dredged by the Challenger; fifteen other species extend to a greater depth than 1000 fathoms and less than 2000. Of the twenty-four species which approach or extend to the lower continental limit, five extend to beyond 2000 fathoms, two to beyond 1500 fathoms, and three to over 1000 fathoms. The abyssal species are distributed as follows:—

CIDARIDÆ (2 species).
Porocidaris, 2.

ARBACIADÆ (2 species).
Podocidaris, 2.

DIADEMATIDÆ (2 species).
Aspidodiadema 2.

ECHINOTHURIDÆ (11 species).
Asthenosoma, 2.
Phormosoma, 9.

TEMNOPLEURIDÆ (3 species).
Prionechinus, 1.
Cottaldia, 1.
Trigonocidaris, 1.

Or twenty species of Desmosticha representing nine genera.

The Clypeastridæ have completely disappeared with the exception of *Pygaster* (this, however, like a few other species here included in the abyssal list may hereafter prove to belong to the continental fauna) and of the few littoral species having great bathymetrical range.

Among the Petalosticha we find a great development of species of genera represented in the Tertiary and Cretaceous periods. Of the Desmosticha the families characteristic of the littoral faunæ have either completely disappeared or are but scantily represented by genera with an ancient geological facies, or genera having a considerable range in time. We find the Petalosticha distributed in the following genera:—

BRISSINA (7 species).
Cionobrissus, 1.
Aërope, 1.
Aceste, 1.
Hemiaster, 4.

While all the other species (twenty-two) belong to the typical deep-sea groups of Pourtalesiæ and Ananchytidæ distributed in the following genera:—

Palæotropus, 2.
Homolampas, 2.
Linopneustes, 1.
Argopatagus, 1.
Urechinus, 1.
Cystechinus, 3.
Calymne, 1.
Genicopatagus, 1.
Echinocrepis, 1.
Spatagocystis, 1.
Pourtalesia, 8.

Or twenty-nine species of Petalosticha distributed in fifteen genera.

In each one of the bathymetrical belts we have recognised, we find, as an inspection of the table will show, an encroachment at both the upper and lower limits of each zone by exceptional species, which wander into far greater depths, and become associated in succession with the species of the preceding and succeeding zones, and thus modify to a considerable extent the characteristic physiognomy of each bathymetrical belt.

Supplementary Abyssal List.

Associated with the 50 strictly abyssal species are 24 other species, of which 14 marked C.+ on the supplementary list are continental, but have a very much greater range in depth than the continental species as a whole; the other 10 are littoral species, marked L.++, which extend in some geographical district or other, not only into the continental range, but far into the abyssal fauna.

	Range in Depth. Fathoms.	Principal Localities.
DESMOSTICHA, Hæckel.		
CIDARIDÆ, Müll.		
GONIOCIDARIDÆ, Hæckel.		
Dorocidaris, A. Ag.		
L.++× *D. papillata*, A. Ag.,	-874 B.	Caribbean Islands; Philippines; La Plata; South Atlantic.
Goniocidaris, Des.		
L. ++ *G. canaliculata*, A. Ag.,	-1975 C.	Patagonia; Australia; Cape of Good Hope; Antarctic.
SALENIDÆ, Agass.		
Salenia, Gray.		
C. +* *S. hastigera*, A. Ag.,	100–1850 C.	Philippines; Indian Archipelago.
C. +× *S. varispina*, A. Ag.,	60–1675 B. C.	Florida; Canary Islands.
ARBACIADÆ, Gray.		
Cœlopleurus, Agass.		
C. + *C. floridanus*, A. Ag.,	56–1323 B.	Florida; Caribbean Islands.
DIADEMATIDÆ, Peters.		
Aspidodiadema, A. Ag.		
C. +* *A. tonsum*, A. Ag.,	100–1700 C.	Philippines; Kermadec; Macio.
Micropyga, A. Ag.		
C. +* *M. tuberculatum*, A. Ag.,	100–610 C.	Philippines; Fiji Islands.
ECHINOTHURIDÆ, Wy. Thom.		
Phormosoma, Wy. Thom.		
C. + *P. sigsbei*, A. Ag.,	120–1250 B.	West India Islands.
ECHINIDÆ, Agass.		
TEMNOPLEURIDÆ, Des.		
Temnechinus, Forbes.		
C. + *T. maculatus*, A. Ag.,	30–600 B. J.	Caribbean Islands Azores.
TRIPLECHINIDÆ, A. Ag.		
Echinus, Rond. (Linn.).		
L.++× *E. acutus*, Lamk.,	-1350 C.	Norway; Ascension; Kermadec; New York.
C. +× *E. elegans*, Dub. o. Kor.,	80–1350 C.	Norway; South Atlantic; Papua; New York.
L.++× *E. magellanicus*, Phil.,	-1600 C.	Patagonia; Australia; Cape of Good Hope; Antarctic.
C. +× *E. norvegicus*, Düb. o. Kor.,	80–2435 B. P.	Norway; Mediterranean; Florida; Japan.
C.+ *E. wallisii*, A. Ag.,	257–1047 B.	Atlantic Coast of U.S. (So. and Mid. States).

	Range in Depth. Fathoms.	Principal Localities.
CLYPEASTRIDÆ, Agass.		
EUCLYPEASTRIDÆ, Hæckel.		
FIBULARINA, Gray.		
Echinocyamus, Van Phelps.		
L.++×*E. pusillus*, Gray, . .	–805 B.	Norway; Azores; Caribbean Islands; Brazil.
Fibularia, Lamk.		
L.++×*F. australis*, Desml., . .	–950 C.	Japan; Sandwich Islands; New South Wales.
PETALOSTICHA, Hæckel.		
CASSIDULIDÆ, Agass.		
NUCLEOLIDÆ, Agass.		
Neolampas, A. Ag.		
C. + *N. rostellata*, A. Ag., . .	100–690 B. P.	North-East Atlantic; Caribbean Islands.
SPATANGIDÆ, Agass.		
SPATANGINA, Gray.		
Maretia, Gray.		
L.++×*M. alta*, A. Ag., ...	–800 C.	Arafura Sea; Japan.
Echinocardium, Gray.		
L.++×*E. australe*, Gray, . .	–2675 C.	New Zealand; Australia; East India Islands; Cape of Good Hope; Mozambique.
BRISSINA, Gray.		
Brissopsis, Agass.		
L.++×*B. luzonica*, A. Ag., . .	–1100 C.	Luzon; New Caledonia; Japan.
L.++×*B. lyrifera*, Agass., . .	–2435 P.	Norway; Mediterranean; Cape of Good Hope; Caribbean Islands; Greenland.
Schizaster, Agass.		
C. +× *S. fragilis*, Agass., . .	83–955 B.	Norway; Gulf of St Lawrence; Florida; Cape of Good Hope; Caribbean Islands.
C. +* *S. moseleyi*, A. Ag., . .	40–1375 C.	Marion Island; Straits of Magellan.
C. +*S. orbignyanus*, A. Ag., . .	92–1557 B.	Caribbean Sea.

To recapitulate, we may state that of the 297 known species of Echinids no less than 201 species are littoral, 46 are continental, and 50 abyssal or oceanic. Of the littoral species, 36 extend beyond the 100 fathom line into the continental range, and of these 10 also extend beyond it into the abyssal range. The species having the greatest bathymetrical range (over 1000 fathoms) are—

Goniocidaris canaliculata, ...	littoral to 1975 fathoms.
Echinus acutus, ...	„ 1350 „
Echinus magellanicus, ...	„ 1600 „
Echinocardium australe, ...	„ 2675 „
Brissopsis luzonica, ...	„ 1100 „
Brissopsis lyrifera, ...	„ 2435 „

Of the continental species 14 extend beyond the usual limits of the continental range

into the abyssal fauna; and the following continental species have an extreme range of more than 1000 fathoms:—

Salenia hastigera, ...	100–1850 fathoms.
Salenia varispina, ...	60–1675 „
Cœlopleurus floridanus, ...	56–1323 „
Aspidodiadema tonsum, ...	100–1700 „
Phormosoma sigsbei, ...	120–1250 „
Echinus elegans, ...	80–1300 „
Echinus norvegicus, ...	80–2435 „
Schizaster moseleyi, ...	40–1375 „
Schizaster orbignyanus, ...	92–1557 „

Among the Clypeastridæ both *Echinocyamus* and *Fibularia* have a range of nearly 1000 fathoms. Finally, of the abyssal species the following have a greater range than 1000 fathoms:—

Aspidodiadema microtuberculatum, ...	804–2225 fathoms.
Pourtalesia laguncula, ...	345–2900 „
Calymne relicta, ...	620–2650 „
Homolampas fragilis, ...	300–1920 „

and quite a number of other species of which the range approaches 1000 fathoms but is below it, showing thus that a very large proportion of the known Echinids have an extraordinary bathymetrical range, and that distributed as these are among all the families and principal groups of Echinids, it is evident we cannot look upon pressure alone as a very important feature in the limitation of the bathymetrical range, but that we must rather look to the difference of temperature characterising the three belts here recognised as the principal element in the distribution of the Echinids in the depths of the ocean.

The genera characteristic of the littoral faunæ which disappear from the continental limits, exclusive of the species having a great bathymetrical range, are the greater number of the species of Cidaridæ—

Cidaris.	*Stephanocidaris.*
Phyllacanthus.	*Arbacia.*

The greater number of the Diadematidæ—

Diadema.	*Echinothrix.*
Centrostephanus.	*Astropyga.*

All the Echinometradæ—

Colobocentrotus.	*Strongylocentrotus.*
Heterocentrotus.	*Sphærechinus.*
Echinometra.	*Pseudoboletia*
Parasalenia.	*Echinostrephus.*
Stomopneustes.	

Nearly all the Temnopleuridæ—

Temnopleurus.	*Mespilia.*
Pleurechinus.	*Amblypneustes.*
Microcyphus.	*Holopneustes.*
Salmacis.	

And of the Triplechinidæ only a few species of *Echinus* are left, while *Hemipedina*, *Phymosoma*, *Toxopneustes*, *Hipponoe*, and *Evechinus* have no representatives.

All the littoral Clypeastridæ have disappeared from among the continental species with the exception of those having a wide bathymetrical range (×). There is not a single typical continental species belonging to either—

×*Echinocyamus.*	*Arachnoides.*
×*Fibularia.*	*Echinodiscus.*
Clypeaster.	×*Mellita.*
Echinanthus.	*Astriclypeus.*
Laganum.	*Rotula.*
×*Peronella.*	*Encope.*
×*Echinarachnius.*	

Among the Petalosticha the following genera are missing :—

Echinoneus.	*Palæostoma.*
×*Echinolampas.*	*Tripylus.*
Rhynchopygus.	×*Brissopsis.*
Echinobrissus.	*Brissus.*
Nucleolites.	*Metalia.*
Anochanus.	*Meoma*
Platybrissus.	*Linthia.*
Maretia.	*Faornia.*
Lovenia.	*Moira.*
Breynia.	

The following genera are represented by different species in the littoral and in the continental bathymetrical ranges :—

Dorocidaris.	*Echinocardium.*
Goniocidaris.	*Rhinobrissus.*
Asthenosoma.	*Agassizia.*
Echinus.	*Schizaster.*
Spatangus.	

Showing how sharply the continental genera contrast with those of the littoral faunæ. Of the 72 genera represented in the different littoral faunæ only 9 are common to both the littoral and continental ranges, when we separate the species which are littoral, and happen to extend either into or through the continental range into the abyssal range, and as these species are very numerous, considerable care must be taken to separate them from the continental species. They are added to the continental lists, and are marked $L.^{+}$ when extending only into the continental range, and $L.^{++}$ when they extend also into the abyssal range; while when we compare the littoral genera and the abyssal we find only two genera, *Asthenosoma* and *Hemiaster*, which have strictly characteristic littoral species.

Comparing in the same way the continental and the abyssal ranges, the following genera found in the continental range do not extend into the abyssal:—

Dorocidaris.	*Catopygus.*
Goniocidaris.	*Paleopneustes.*
Salenia.	*Spatangus.*
Cœlopleurus.	*Nacopatagus.*
Micropyga.	*Echinocardium.*
Temnechinus.	*Rhinobrissus.*
Hemipedina.	*Agassizia.*
Neolampas.	*Schizaster.*
Conoclypus.	*Moiropsis.*

That is, in addition to the 9 genera of which there are representative species in both the littoral and continental ranges, there are 11 genera eminently characteristic of the continental range; while the following genera have representative species both in the continental and abyssal ranges:—

Porocidaris.	*Asthenosoma.*
Podocidaris.	*Phormosoma.*
Aspidodiadema.	*Trigonocidaris.*

Or only 6 genera thus far out of 47 which are found extending from the continental line to the abyssal range and including both; while the following genera are eminently abyssal, and have thus far not been found to extend into the continental range among the recent species.

Prionechinus.	*Spatagocystis.*
Cottaldia.	*Echinocrepis.*
Pygaster.	*Urechinus.*
Pourtalesia.	*Cystechinus.*

Calymne.	*Linopneustes.*
Palæotropus.	*Cionobrissus.*
Genicopatagus.	*Aerope.*
Homolampas.	*Aceste.*

That is, we have 16 genera which are eminently abyssal out of the 24 genera extending into the abyssal region, exclusive, of course, of the species which have an abnormal bathymetrical range and spread from the littoral to the greatest depth at which Echinids have been dredged. The abyssal genera belong nearly all to a new group of Spatangoids related to those of the Chalk and have no allies among the littoral species.

Geographical Range of the Continental and Abyssal Species.

As regards the geographical range of the continental, and of the abyssal species, we have, unfortunately, no data for the Indian Ocean, and we must therefore limit our comparisons of geographical distributions entirely to the littoral faunæ thus far recognised in the Atlantic and Pacific.

Examining in the first place the continental species by themselves, we find a far greater proportion of representative species among the Atlantic and Pacific continental species than we find when comparing the corresponding littoral faunæ; and if we take, as perhaps belonging to the continental species, a few species of which only a few or single specimens were collected, the representative character of the Atlantic and Pacific continental geographical faunæ is quite striking.

We find both in the Atlantic and in the Pacific species of *Porocidaris*, *Salenia*, *Podocidaris*, *Cœlopleurus*, *Aspidodiadema*, *Asthenosoma*, *Phormosoma*, *Trigonocidaris*, *Echinus*, *Paleopneustes*, *Rhinobrissus*, *Agassizia*, *Schizaster*, and *Periaster*.

Such species as *Goniocidaris* may belong perhaps to the littoral range; we have left thus far among the continental species characteristic of the Atlantic only a small number of genera, *Temnechinus*, *Hemipedina*, *Neolampus*, *Conoclypus*, and as characteristic of the Pacific continental ranges *Micropyga*, *Catopygus*, *Nacopatagus*, and *Moiropsis*. A condition of things totally unlike that is found when comparing the same districts with regard to the occurrence of the same genera. That is, among 22 genera of the continental range 14 are represented both in the Atlantic and Pacific, while there are thus far four distintly Pacific genera, and as many Atlantic ones, while of the littoral faunæ, only six are characteristic of the Atlantic, 31 genera as common to both, and 36 are thus peculiar to the Pacific.

When we examine the abyssal species, leaving out of consideration the few which may perhaps belong to the continental range, of which we have not sufficient data, such as *Podocidaris*, *Aspidodiadema*, *Prionechinus*, *Cottaldia*, *Pygaster*, and *Linopneustes*, we find as common to the Atlantic and Pacific the following genera :—*Asthenosoma*,

Phormosoma, Pourtalesia, Palæotropus, Homolampas, Hemiaster, Aceste, Aërope, Cystechinus, and *Urechinus;* while we find as eminently characteristic of the Southern Ocean such strange forms of Pourtalesiæ as *Spatagocystis, Echinocrepis,* and *Genicopatagus,* which may hereafter be found to extend north into both the Atlantic and Pacific, if we can judge of the extension of the few species of *Pourtalesia, Cystechinus,* and *Urechinus* into the Atlantic and Pacific from their numerous representatives in the Southern and Antarctic Oceans; while thus far as strictly Pacific we have only of the abyssal species *Cionobrissus* and *Argopatagus,* and as strictly Atlantic only *Calymne,* and perhaps *Pygaster,* showing from the bathymetrical range that the abyssal species proper are few in number, are mainly limited to the Southern Ocean, and extend northward both into the Atlantic and Pacific realms. That the continental species form no such restricted littoral faunæ as are characteristic of the species, having a narrow bathymetrical range, but that we have as it were an Atlantic and a Pacific realm, which we are perhaps justified in considering as off-shoots of the great separation which took place, dividing the great Southern Ocean when it extended uninterruptedly over the whole Southern Hemisphere, or at any rate when South America separated the Atlantic from the Pacific only as a large island or an archipelago, geographical off-shoots of a time when the genera characteristic of these two great realms may have been represented in the Atlantic and Pacific Gulfs (to use Thomson's happy terminology) by identical species; these now, in our present epoch, bear to each other much the same relationship which the littoral species on the two sides of the isthmus bear to one another, and measure as in that case the degree of change or time which has elapsed since the separation has taken place, resulting in a condition of things making a separation of the deep-sea forms into an Atlantic and a Pacific continental realm possible. Just as the subsequent further isolation of districts in the Atlantic and Pacific may gradually have brought about a centralisation into littoral faunæ such as are generally recognised; while the species which have a great bathymetrical or geographical range are those which have escaped the influence of these changes, some of them which extend from the littoral to the abyssal going back to the time when the Atlantic and Pacific realms were not yet isolated, and thus explaining the existence of the same species at distant geographical points, while others extending only to the continental range from the littoral, recall the time when the Atlantic and Pacific realms were already separated, and when the species of the continental range appeared as representative species in the Atlantic and Pacific; while those species which extend from the continental to the abyssal have never been subject to the influences which have gone to form either the continental ranges alone, or the littoral range. The genera which have this great bathymetrical range are the following: I have marked with T. genera which occur in the Tertiary, and with C. those which occur in the Cretaceous.

L.$^{+}$ *Meoma*, T.
L.$^{++}$ *Schizaster*, T.
L.$^{+}$ *Metalia*, T.
C.$^{+}$ *Neolampas.*
L.$^{++}$ *Brissopsis.*
L.$^{++}$ *Hemiaster*, C.
L.$^{++}$ *Echinocardium*, T.
L.$^{+}$ *Spatangus*, T.
L.$^{++}$ *Maretia*, T.
L.$^{+}$ *Echinolampas*, T.
L.$^{+}$ *Mellita*, recent.
L.$^{+}$ *Peronella*, recent.
L.$^{+}$ *Clypeaster*, T.
L.$^{+}$ *Echinanthus*, T.
L.$^{++}$ *Echinocyamus*, C.
L.$^{++}$ *Fibularia*, C.
L.$^{+}$ *Toxopneustes*, T.
L.$^{+}$ *Hipponoë*, T.
L.$^{++}$ *Echinus*, C.
L.$^{+}$ *Salmacis*, T.
C.$^{+}$ *Temnechinus*, C.
L.$^{+}$ *Temnopleurus*, T.
L.$^{+}$ *Sphærechinus.*
L.$^{+}$ *Echinometra*, T.
C.$^{+}$ *Phormosoma* (Echinothuridæ, C.).
C.$^{+}$ *Micropyga.*
C.$^{+}$ *Cœlopleurus*, T. (*Magnosia*, C.).
L.$^{+}$ *Arbacia*, T.
C.$^{+}$ *Salenia*, C.
L.$^{++}$ *Goniocidaris*, recent.
L.$^{+}$ *Cidaris*, T.
L.$^{++}$ *Dorocidaris*, C.

It is interesting to note that all the genera which have the greatest bathymetrical range, which extend from the littoral to the abyssal region, are at the same time genera which date back to the Cretaceous, while those which have a somewhat more limited range date back to the Tertiaries, and those genera which happen to extend only slightly beyond the strictly littoral range date back only to the more recent Tertiary periods. Of course the difficulty of tracing the connection between the species of the present epoch, which may have ranged in the Tertiary, in shallow seas, or in deeper water is very great, and the mixture thus created in the littoral fauna of the present day it is practically impossible to disentangle at present, if we take into account the impossibility of determining what are strictly deep-sea genera at the present day on account of the great bathymetrical range of many genera, and the possibility that what may be to-day a littoral species may have been a deep-water genus in older geological times or *vice versa.*

The extremes of temperature which we find in the sea at different depths characterising the different bathymetrical regions we have recognised are much smaller than the extremes of temperature which characterise our terrestrial fauna and flora. We have no such extremes as are distinguished on land between a tropical and an arctic fauna or between a fauna in the tropics near the level of the sea and one near the lower limit of perpetual snow. Yet in the one case the difference in pressure of the surrounding medium is small, say at the outside there is not a greater difference than two-thirds, while between the abyssal regions and the littoral regions we have no such extreme of temperatures, but extremes of pressure represented by a ratio of one to three hundred

at the average depth of the Atlantic and Pacific basins, which does not seem to have practically any influence whatever on the distribution of species; while the slight range of temperature which affects the upper layers of the waters so as to form a littoral fauna within the limits where we have the greatest possible differences between the extremes of heat and cold, due to the daily changes of the temperature, and a continental fauna extending to those depths which we may assume are affected by the slower action of the heat of the sun at different seasons; while at last we find the abyssal regions in which the changes of temperature can be considered as null and in which there is a most remarkable uniformity of temperature though the conditions of pressure at the extremes of depths to which the species belonging to this abyssal fauna range are immensely greater than corresponding extremes due to the difference of atmospheric pressure at different levels on the surface of the earth.

If we examine the physical conditions which prevail within the 100 fathom line, within the continental limits, and within the oceanic limits, we, of course, at first would be inclined to look upon the great differences of pressure as the important element in the limitation of faunæ. The fact, however, that one and the same species so readily adapts itself to the enormous differences of pressure occurring in the oceanic, continental, and even littoral districts would seem to show that this element is not an all-important one. It is among the littoral districts that we find the greatest diversity of faunæ, and these littoral districts mainly differ in their temperature, but it is not the greatest amount of heat which apparently forms the limits of these districts.

They are separated by lines of lowest temperatures. Thus we find an arctic and boreal district, a temperate and a tropical district in which the extremes of temperature range within comparatively narrow limits. A similar condition of things exists within the littoral, continental, and abyssal districts; they represent the depths at which as a general rule certain well marked conditions of temperature exist, regulating as they do for the littoral districts the principal faunistic features of the bathymetrical districts. The littoral where the changes of temperature are greatly affected by the action of the sun; the continental extending from this limit into regions where we find the temperature gradually diminishing till we come to the abyssal or oceanic depths at which we have practically a uniform temperature.

With the exception of the abyssal species found in the Southern Ocean near the Antarctic circle, none of the species of Echinids seem to extend to very great distances from the continental ranges. This agrees well with my own observations in the "Blake," where I found that at even a comparatively short distance from the land there was a marked diminution in the number of species, and also in the number of specimens collected. The greatest distances from any land or banks of moderate depths at which Echinids have been collected are off Tristan da Cunha, at Stations 133, 334, 335; at Stations 153, 156, 157, 158 in the Southern Ocean, south of the Heard Islands, which, however, may not

be very far from the Antarctic continent; at Station 70 to the westward of the Azores; at Stations 296 and 302 to the westward of the southern coast of Chili; and at Station 106 to the east of the Island of St Paul. In no case is the distance greater than six hundred miles, but it is difficult with this range from shores to draw the outline of any land in such a way that the great continental masses will not be connected in several places, or at any rate will only leave comparatively restricted oceanic areas which would not fall within the lines. Such an area would be found in the North Atlantic in the rectangle formed by the Bermudas, Sombrero, Cape Verde Islands, and the Azores. A smaller area in the South Atlantic, limited by the eastern coast of South America, Ascension, St Helena, Tristan da Cunha, and the Falkland Islands; another in the central part of the Indian Ocean; a smaller area to the south-west of Australia towards the Antarctic circle; and two areas in the Pacific, one extending from north-west to south-east from the 20° of northern latitude, and about the same latitude south, and one extending from east to west, south of latitude 30° S. towards the Antarctic circle—and an elongated area in the northern part of the Pacific which may perhaps be considered only as an area of the first-mentioned district.

In the accompanying geographical lists the species collected by the Challenger and already known from the same districts are marked × ; those previously known but found in the district for the first time by the Challenger are marked ⊕, and the species discovered by the Challenger are marked *.

Northern Chili—Rio La Plata.

	Range in Depth and Principal Localities.
DESMOSTICHA, Hæckel.	
CIDARIDÆ, Müll.	
GONIOCIDARIDÆ, Hæckel.	
Goniocidaris, Des.	
× *G. canaliculata*, A. Ag.,	Falkland Islands, 5–10 fathoms; Straits of Magellan; ×Station 313, 55 fathoms; ×Station 315, 6–12 fathoms (Southern Ocean).
ARBACIADÆ, Gray.	
Arbacia, Gray.	
× *A. dufresnii*, Gray,	East Patagonia, 44 fathoms B.; Chili; ×Station 304, 45 fathoms; ×Station 308, 175 fathoms (Southern Ocean).
× *A. nigra*, A. Ag.,	Cape Horn; Chili (Philippines).
× *A. spatuligera*, A. Ag.,	Chili.
DIADEMATIDÆ, Peters.	
Aspidodiadema, A. Ag.	
**A. microtuberculatum*, A. Ag.,	×Station 298, 2225 fathoms; ×Station 299, 2160 fathoms (Atlantic; Southern Ocean).

	Range in Depth and Principal Localities.
ECHINOTHURIDÆ, Wy. Thom.	
Phormosoma, Wy. Thom.	
**P. asterias*, A. Ag.,	×Station 299, 2160 fathoms (Southern Ocean).
**P. hoplacantha*, Wy. Thom.,	×Station 300, 1375 fathoms (Southern Ocean).
ECHINOMETRADÆ, Gray.	
Colobocentrotus, Br.	
C. atratus, Br.,	Chili (African; Indian; Pacific).
Strongylocentrotus, Br.	
S. albus, A. Ag.,	Straits of Magellan; Chili (Philippines).
×*S. gibbosus*, A. Ag.,	Straits of Magellan; Chili; ×Station 304, 45 fathoms.
ECHINIDÆ, Agass.	
TRIPLECHINIDÆ, A. Ag.	
Echinus, Rond. (Linn.).	
**E. horridus*, A. Ag.,	×Station 308, 175 fathoms.
×*E. magellanicus*, Phil.,	Straits of Magellan, 57 fathoms; Chili; East Patagonia, 44 fathoms B.; ×Station 315, 5–12 fathoms; ×Station 304, 45 fathoms; ×Station 308, 175 fathoms; ×Station 312, 10–15 fathoms (Southern Ocean).
×*E. margaritaceus*, Lamk.,	Straits of Magellan; Chili; ×Station 308, 175 fathoms; ×Station 311, 245 fathoms (Southern Ocean).
⊕*E. norvegicus*, Düb. o. Kor.,	×Station 308, 175 fathoms (Atlantic; Japan).
PETALOSTICHA, Hæckel.	
SPATANGIDÆ, Agass.	
POURTALESIÆ, A. Ag.	
Pourtalesia, A. Ag.	
**P. carinata*, A. Ag.,	×Station 298, 2225 fathoms (Antarctic).
**P. ceratopyga*, A. Ag.,	×Station 298, 2225 fathoms; ×Station 299, 2160 fathoms (Antarctic).
Urechinus, A. Ag.	
**U. naresianus*, A. Ag.,	×Station 302, 1450 fathoms (Antarctic, Caribbean).
Cystechinus, A. Ag.	
**C. vesica*, A. Ag.,	×Station 298, 2225 fathoms; ×Station 299, 2160 fathoms (Antarctic).
**C. wyvillii*, A. Ag.,	×Station 296, 1825 fathoms; ×Station 299, 2160 fathoms; ×Station 300, 1375 fathoms (Antarctic).
SPATANGINA, Gray.	
Nacopatagus, A. Ag.	
N. gracilis, A. Ag.,	Juan Fernandez, 65 fathoms B.
BRISSINA, Gray.	
Hemiaster, Des.	
×*H. cavernosus*, A. Ag.,	East Patagonia, 44–55 fathoms B.; Chili; ×Station 310, 400 fathoms; Off La Plata, 50 fathoms B. (Southern Ocean).
Tripylus, Phil.	
T. excavatus, Phil.,	East Patagonia, 44 fathoms B.; Chili.
Agassizia, Val.	
A. excentrica, A. Ag.,	Off La Plata, 44 fathoms B. (Caribbean).
A. scrobiculata, Val.,	Juan Fernandez, 220 fathoms B. (Peruvian).
Schizaster, Agass.	
**S. moseleyi*, A. Ag.,	×Station 305, 120 fathoms; ×Station 307, 147 fathoms; ×Station 309, 40–140 fathoms; ×Station 310, 400 fathoms; ×Station 311, 245 fathoms (Southern Ocean).
S. philippii, A. Ag.,	La Plata; Chili.

The following species having a continental and abyssal range find their way into the South American district :—

Aspidodiadema microtuberculatum, Atlantic and Pacific.	*Cystechinus vesica*, Southern Ocean.
Phormosoma asterias, Southern Ocean.	*Cystechinus wyvillii* „
Phormosoma hoplacantha „	*Pourtalesia carinata* „
Urechinus naresianus „	*Pourtalesia ceratopyga* „
	Schizaster moseleyi „

Echinus norvegicus is the only European boreal species not hitherto found at the southern extremity of South America collected by the Challenger with a new species of *Echinus* (*E. horridus*), all the other species are evidently only northern extensions of the Southern Ocean abyssal species. *Schizaster moseleyi* is also a more shallow Southern Ocean species. The South American district seems to be like that of the Cape of Good Hope; it has no species peculiar to itself, and is the meeting ground of the southern limits of the Brazils, Virginia, of the Atlantic, of the Southern Ocean, and of the southern extremity of the Peru-Chili districts.

Southern Brazil—Eastern Virginia.

	Range in Depth and Principal Localities.
DESMOSTICHA, Hæckel.	
Cidaridæ, Müll.	
Goniocidaridæ, Hæckel.	
Cidaris, Kl.	
× *C. tribuloides*, Bl., ...	South Carolina; West Indies, 20–250 fathoms B.; Florida, Gulf Stream, 116 fathoms; Tortugas, 30–36 fathoms; Rio Janeiro; ×Fernando Noronha; ×Bahia, 7–20 fathoms (North Atlantic).
Dorocidaris, A. Ag.	
D. bartletti, A. Ag., ...	Caribbean Islands, 76–398 fathoms B.
D. blakii, A. Ag., ...	Caribbean Islands, 158–450 fathoms B.
× *D. papillata*, A. Ag., ...	Florida, Gulf Stream, 40–195 fathoms B.; Caribbean Islands, L. –874 fathoms B.; ×Station 24, 390 fathoms; ×St Paul Rocks, 70–80 fathoms; ×Station 320, 600 fathoms (Atlantic; Pacific).
Porocidaris, Des.	
P. sharreri, A. Ag., ...	Caribbean Islands, 123–351 fathoms B.
Salenidæ, Agass.	
Salenia, Gray.	
S. goesiana, Lov., ...	Caribbean Islands, 180 fathoms J.
**S. hastigera*, A. Ag., ...	×Station 106, 1850 fathoms; ×Station 335, 1425 fathoms (Pacific).
S. pattersonii, A. Ag., ...	Caribbean, 82–450 fathoms B.
× *S. varispina*, A. Ag., ...	Florida, Gulf Stream, 135 fathoms; Caribbean Islands, 120–1200 fathoms B.; ×Station 23, 450 fathoms; ×Station 24, 390 fathoms (Atlantic).

	Range in Depth and Principal Localities.
ARBACIADÆ, Gray.	
Arbacia, Gray.	
A. punctulata, Gray, ...	North Carolina, 7 fathoms; Florida, Gulf Stream, 13–125 fathoms B.; Yucatan; Caribbean, 14–84 fathoms B.
A. pustulosa, Gray, ...	St Thomas; Rio Janeiro (Atlantic).
Podocidaris, A. Ag.	
×*P. sculpta*, A. Ag., ...	Florida, Gulf Stream, 120–315 fathoms; Caribbean, 250–400 fathoms B.; ×Station 24, 390 fathoms.
P. scutata, A. Ag., ...	Caribbean Islands, 580 fathoms B.
Cœlopleurus, Agass.	
C. floridanus, A. Ag., ...	Florida, Gulf Stream, 160 fathoms; Caribbean, 56–1523 fathoms B.
DIADEMATIDÆ, Peters.	
Diadema, Schynv.	
D. setosum, Gray, ...	South Florida; Surinam; Bermudas; Caribbean, 60–291 fathoms B.; Santaren Channel, 40 fathoms (Atlantic; Pacific).
Aspidodiadema, A. Ag., ...	
**A. microtuberculatum*, A. Ag., .	Caribbean Islands, 860–1400 fathoms B.; ×Station 134, 2025 fathoms; ×Station 122, 356 fathoms (Atlantic; South Pacific).
A. antillarum, A. Ag., . . .	Caribbean Islands, 208–1200 fathoms B.
A. jacobyi, A. Ag., ...	Caribbean Islands, 95–287 fathoms B.
ECHINOTHURIDÆ, Wy. Thom.	
Asthenosoma, Grube.	
A. hystrix, A. Ag., ...	Florida, Gulf Stream, 138 fathoms; Caribbean Islands, 100–1097 fathoms B. (North Atlantic).
A. reynoldsii, A. Ag., . . .	Caribbean Islands, 180–375 fathoms B.
Phormosoma, Wy. Thom.	
P. sigsbei, A. Ag., ...	Caribbean Islands, 120–1242 fathoms B.
P. petersii, A. Ag., ...	Caribbean Islands, 399–1234 fathoms B.
ECHINOMETRADÆ, Gray.	
Echinometra, Rondel. (Breyn.)	
×*E. subangularis*, Desml., . .	South Carolina; Bermudas; Rio Janeiro; Caribbean Islands, 14–250 fathoms B.; ×Ascension Island (Atlantic).
E. viridis, A. Ag., ...	Florida, Gulf Stream, 7 fathoms; Hayti; West Indies.
Strongylocentrotus, Br.,	
S. dröbachiensis, A. Ag., . .	South Carolina (Arctic).
S. gaimardi, A. Ag., . . .	Brazil.
S. lividus, Br., ...	Bahia; Rio Janeiro (Atlantic).
ECHINIDÆ, Agass.	
TEMNOPLEURIDÆ, Des.	
Temnechinus, Forbes.	
T. maculatus, A. Ag., ...	Florida, Gulf Stream, 10–147 fathoms; Caribbean Islands, 37–229 fathoms B. (North Atlantic).
Trigonocidaris, A. Ag.	
T. albida, A. Ag., ...	Florida, Gulf Stream, 40–270 fathoms; Caribbean Islands, 24–450 fathoms B. (North Atlantic).
TRIPLECHINIDÆ, A. Ag.	
Hemipedina, Wright.	
H. cubensis, A. Ag., ...	Florida, Gulf Stream, 138–270 fathoms B.

	Range in Depth and Principal Localities.
Echinus, Rond. (Linn.).	
⊕*E. acutus*, Lamk.,	×Station 343, 425 fathoms (Atlantic; Pacific).
⊕*E. elegans*, Düb. o. Kor.,	×Tristan da Cunha, 1100 fathoms (Atlantic; Pacific).
E. gracilis, A. Ag.,	Florida, Gulf Stream, 100–200 fathoms; St Thomas; Caribbean, 175 fathoms B.
E. norvegicus, Düb. o. Kor.,	Florida, Gulf Stream, 195 fathoms; Atlantic Coast of U. S., 1242 fathoms B.; (Atlantic; Japan).
E. wallisii, A. Ag.,	Atlantic Coast of U. S. (South and Middle States), 267–1047 fathoms B.
Toxopneustes, Agass.	
×*T. variegatus*, A. Ag.,	North Carolina, 7 fathoms; Bermudas; Florida, Gulf Stream, 5–34 fathoms; Caribbean Islands, 14–242 fathoms B.
Hipponoë, Gray.	
H. esculenta, A. Ag.,	South Florida; Bermudas; Surinam; Caribbean Islands, 14–451 fathoms B.
CLYPEASTRIDÆ, Agass.	
ECHINOCONIDÆ, D'Orb.	
Pygaster, Agass.	
P. relictus, Lov.,	Virgin Islands, 180 fathoms J.
EUCLYPEASTRIDÆ, Hæckel.	
FIBULARINA, Gray.	
Echinocyamus, Van Phelps.	
×*E. pusillus*, Gray,	Florida, Gulf Stream, 5–325 fathoms; Caribbean Islands, 98–805 B.; ×Station 122. Off Barra Granda (no depth on label), (North Atlantic).
ECHINANTHIDÆ, A. Ag.	
Clypeaster, Lamk.	
×*C. subdepressus*, Agass.,	South Carolina; Brazil; Florida, Gulf Stream, 11–40 fathoms; Florida; Caribbean Islands, 36–248 fathoms B. (North Atlantic).
Echinanthus, Breyn.	
E. rosaceus, Gray,	South Carolina; West Indies; Caribbean Islands, 14–118 fathoms B.
SCUTELLIDÆ, Agass.	
Mellita, Kl.	
×*M. sexforis*, A. Ag.,	South Carolina; Bermudas; West Indies; Florida, Gulf Stream, 4–270 fathoms; ×Bahia.
M. testudinata, Kl.,	East Virginia; West Indies; Rio Janeiro.
Encope, Agass.	
×*E. emarginata*, Agass.,	South Carolina; West Indies; Florida, Gulf Stream, 7 fathoms; Rio Janeiro; ×Bahia, 20–70 fathoms.
E. michelini, Agass.,	Alabama; West Florida; Honduras; Yucatan; Florida, Gulf Stream, 5–6 fathoms; Caribbean Islands, 14 fathoms B.
PETALOSTICHA, Hæckel.	
CASSIDULIDÆ, Agass.	
ECHINONIDÆ, Agass.	
Echinonëus, Van Phelps.	
E. semilunaris, Lamk.,	Bermudas; Florida Keys; Caribbean Islands, 80–805 fathoms B.
NUCLEOLIDÆ, Agass.	
Neolampas, A. Ag.	
N. rostellata, A. Ag.,	Florida, Gulf Stream, 112–125 fathoms; Caribbean Islands, 100–229 fathoms B. (North Atlantic).

	Range in Depth and Principal Localities.
Echinolampas, Gray.	
E. depressa, Gray, ...	Florida, Gulf Stream, 35–120 fathoms; Caribbean Islands, 82–160 fathoms B.
Conoclypus, Agass.	
C. sigsbii, A. Ag., ...	Straits of Florida; Yucatan, 84–450 fathoms B.
Rhynchopygus, D'Orb.	
R. caribæarum, Lütk., . . .	Florida, Gulf Stream; West Indies, 106 fathoms B.
SPATANGIDÆ, Agass.	
POURTALESIÆ, A. Ag.	
Pourtalesia, A. Ag.	
P. miranda, A. Ag., . . .	Florida, Gulf Stream, 349 fathoms; Caribbean Islands, 242–576 fathoms B. (North Atlantic).
Urechinus, A. Ag.	
U. naresianus, A. Ag., . . .	Caribbean Islands, 422 fathoms B (Southern Ocean, Atlantic).
Cystechinus, A. Ag.	
**C. clypeatus*, A. Ag., . . .	×Station 133, 1900 fathoms; ×Station 334, 1915 fathoms (South Atlantic; Pacific).
ANANCHYTIDÆ, Alb. Gras.	
Palæotropus, Lov.	
P. josephinæ, Lov., . . .	Caribbean Islands, 177–243 fathoms B. (North Atlantic).
P. thomsoni, A. Ag., . . .	Atlantic Coast, U. S. (South Coast), 233 fathoms B.
Homolampas, A. Ag.	
×*H. fragilis*, A. Ag., . . .	Florida, Gulf Stream, 320–368 fathoms; Caribbean Islands, 320–1920 fathoms B.; ×Station 122, 400 fathoms (North Atlantic).
Paleopneustes, A. Ag.	
P. cristatus, A. Ag., . . .	Straits of Florida; Caribbean Islands, 56–450 fathoms B.
P. hystrix, A. Ag., . . .	Caribbean Islands, 21–208 fathoms B.
Linopneustes, A. Ag.	
L. longispinus, A. Ag., . . .	Caribbean Islands, 28–373 fathoms B.
SPATANGINA, Gray.	
Spatangus, Kl.	
⊕*S. purpureus*, Leske., . . .	×Bermudas, 100 fathoms; Caribbean Islands, 82–373 fathoms B. (North Atlantic).
Echinocardium, Gray.	
E. cordatum, Gray, . . .	North Carolina; Florida Reef, 79 fathoms; Bahia (North Atlantic).
E. flavescens, A. Ag., . . .	South Carolina; Florida, Gulf Stream, 85–138 fathoms; Bahia (Atlantic).
E. pennatifidum, Norm., . . .	Florida, Gulf Stream, 79–121 fathoms (North Atlantic).
BRISSINA, Gray.	
Hemiaster, Des.	
H. expergitus, Lov., . . .	Caribbean Islands, 485 fathoms B. J. (North Atlantic).
**H. zonatus*, A. Ag., . . .	×Station 126, 750 fathoms (North Atlantic).
H. mentzii, A. Ag., . . .	Caribbean Islands, 170–576 fathoms B.
Rhinobrissus, A. Ag.	
R. micrasteroides, A. Ag., . .	Caribbean Islands, 175–242 fathoms B.
Brissopsis, Agass.	
B. lyrifera, Agass., . . .	Florida, Gulf Stream, 53–128 fathoms; Caribbean Islands, 118–242 fathoms B. (Atlantic).
Aceste, Wy. Thom.	
**A. bellidifera*, Wy. Thom., . .	×Station 323, 1900 fathoms (Atlantic; Pacific).

	Range in Depth and Principal Localities.
Agassizia, Val.	
A. excentrica, A. Ag., ...	Florida, Gulf Stream, 35–45 fathoms; Caribbean, 86–287 fathoms B.
Brissus, Kl.	
**B. damesi*, A. Ag., . . .	×Station 122, 400 fathoms (North Atlantic).
B. unicolor, Kl., ...	South Florida, 17–128 fathoms; West Indies; Bermudas (North Atlantic).
Metalia, Gray.	
×*M. pectoralis*, A. Ag., ...	West Florida; West Indies; Bahia; Florida Gulf Stream, 115 fathoms.
Meoma, Gray.	
M. ventricosa, Lütk., ...	Florida; Honduras; Florida, Gulf Stream, 85–115 fathoms; Caribbean Islands, 37–242 fathoms B.
Schizaster, Agass.	
S. fragilis, Agass., ...	Atlantic Coast of U. S.; Florida, Gulf Stream; Caribbean Islands, 71–950 fathoms B. (Atlantic).
S. orbignyanus, A. Ag., ...	Caribbean Islands, 92–1507 fathoms B.
Periaster, D'Orb.	
P. limicola, A. Ag., ...	Gulf of Mexico, 118 fathoms B. (Pacific).
Moira, A. Ag.	
M. atropos, A. Ag., ...	North Carolina; Florida; West Indies; Texas; Florida Gulf Stream, 80 fathoms.

On comparing the species collected by the Challenger in this district, we find that the Challenger traced the existence of *Echinus acutus*, *Echinus elegans*, and *Echinus norvegicus* to the eastward of Cape Cod, and also of *Echinus acutus* as far south as Ascension, and of *Echinus elegans* to Tristan da Cunha; *Cidaris tribuloides* to Fernando Noronha, and *Dorocidaris papillata* to St Paul Rocks and Buenos Ayres. *Salenia varispina* was also found as far as Ascension, and the Northern part of Brazil. *Echinocyamus pusillus Metalia pectoralis* and *Homolampas fragilis* are also found off the latter shores.

Schizaster fragilis has also been found by the United States Fish Commission in the Gulf of Maine; it was found by the Challenger off the Nova Scotia coast, and with the exception of *Pourtalesia phiale* no species from the Southern Ocean find their way northward in the Atlantic. There are found on the western side of the Atlantic of the abyssal species *Aspidodiadema microtuberculatum*, *Urechinus naresianus*, *Cystechinus clypeatus*, *Aceste bellidifera*, and *Hemiaster zonatus*, while *Brissus damesi* is thus far only known from Northern Brazil and the Azores. On the eastern side are found *Aceste bellidifera*, *Hemiaster zonatus*, *Phormosoma uranus*, *Asthenosoma fenestratum*, *Aspidodiadema tonsum*, *Calymne relicta*, *Aerope rostrata*, *Porocidaris purpurata; Salenia hastigera*, and *Salenia varispina; Salenia varispina*, *Brissus damesia*, *Hemiaster zonatus*, *Pourtalesia jeffreysi*, *Neolampas rostrata*, *Temnechinus maculatus*, and *Trigonocidaris albida* being thus far the only strictly Atlantic species. *Spatangus purpureus* was found by the Challenger at the Azores and Bermudas, and I have dredged it from the Caribbean Seas, while we have along this district, as might be expected, quite a well-marked continental fauna agreeing fairly with the associated littoral fauna in geographical range, but, as has been stated, made up of representative species for the greater part.

New Jersey—Iceland.

	Range in Depth and Principal Localities.
DESMOSTICHA, Hæckel.	
Arbaciadæ, Gray.	
Arbacia, Gray.	
A. punctulata, Gray, ...	Cape Cod; Long Island Sound, 20 fathoms (Caribbean).
Echinometradæ, Gray.	
Strongylocentrotus, Br.	
×*S. dröbachiensis*, A. Ag., . .	Iceland; Greenland, 410 fathoms Val.; New England, 100 fathoms; New Jersey; ×Lahave Bank, 51 fathoms; ×Station 49, 83 fathoms (Arctic).
Echinidæ, Agass.	
Triplechinidæ, A. Ag.	
Echinus, Rond. (Linn.)	
⊕*E. acutus*, Lamk., ...	×Station 46, 1350 fathoms (Atlantic; Pacific).
⊕*E. elegans*, Düb. o. Kor., . .	×Station 46, 1350 fathoms (Atlantic; Pacific).
E. esculentus, Linn., . . .	Iceland (East Atlantic).
⊕*E. norvegicus*, Düb. o. Kor., . .	Off New Jersey, 1242 fathoms, B.; ×Station 46, 1350 fathoms; ×Station 47, 1340 fathoms (Atlantic; Japan).
E. wallisii, A. Ag., ...	East Coast U.S. (Middle States), 304–524 fathoms B.
Toxopneustes, Agass.	
T. variegatus, A. Ag., ...	New Jersey (Caribbean).
Clypeastridæ, Agass.	
Euclypeastridæ, Hæckel.	
Fibularina, Gray.	
Echinocyamus, Van Phelps.	
E. pusillus, Gray, ...	Iceland (North Atlantic).
Scutellidæ, Agass.	
Echinarachnius, Leske.	
E. parma, Gray, ...	Labrador, 2–15 fathoms; New Jersey; Off George's Bank, 306 fathoms, B.; Off North West Atlantic Coast; North America, 40 fathoms (Arctic; Indian).
Mellita, Kl.	
M. testudinata, Kl., ...	New Jersey (Caribbean).
Petalosticha, Hæckel.	
Spatangidæ, Agass.	
Pourtalesiæ, A. Ag.	
Pourtalesia, A. Ag.	
P. phiale, Wy. Thom., ...	×North Atlantic, 1785 fathoms (Antarctic; Southern Ocean).
Urechinus, A. Ag.	
U. naresianus, A. Ag., ...	1242 fathoms B, Atlantic Coast of U.S. (Middle States) Southern Ocean, Atlantic.
Brissina, Gray.	
Brissopsis, Agass.	
B. lyrifera, Agass., ...	Greenland (Atlantic).
Aërope, Wy. Thom.	
**A. rostrata*, Wy. Thom., . . .	Davis Straits, 1750 fathoms Val. (Atlantic; Pacific).
Schizaster, Agass.	
×*S. fragilis*, Agass., ...	Gulf of St Lawrence, 250 fathoms; Greenland, 410 fathoms Val.; off R. I. and New Jersey, 71–306 fathoms, B.; ×Station 49, 83 fathoms (Atlantic).

Northern Shores of Siberia—West Coast of France.

	Range in Depth and Principal Localities.
DESMOSTICHA, Hæckel.	
CIDARIDÆ, Müll.	
GONIOCIDARIDÆ, Hæckel.	
Dorocidaris, A. Ag.	
D. papillata, A. Ag., ...	West Coast of Norway, 80–100 fathoms; North Sea, 200 fathoms; Faröe Islands—Gibraltar, 100–1000 fathoms P.; Cape Wrath, 280 fathoms P.; South Ireland, 80–90 fathoms (Atlantic; Pacific).
Porocidaris, Des.	
P. purpurata, Wy. Thom., . .	Shetland Islands; Faröe Islands; Butt of the Lewes, 542 fathoms P.
ARBACIADÆ, Gray.	
Arbacia, Gray.	
A. pustulosa, Gray, ...	West Coast of France (Atlantic).
ECHINOTHURIDÆ, Wy. Thom.	
Asthenosoma, Grube.	
A. hystrix, A. Ag., ...	Shetland Islands; Rockall, 547 fathoms; Butt of the Lewes, 445 fathoms P.; Off Vigo (North Atlantic).
A. fenestratum, Wy. Thom., . .	Rockall, 445 (?) fathoms P. (East Atlantic).
Phormosoma, Wy. Thom.	
P. placenta, Wy. Thom., . . .	West Scotland and Ireland, 500–800 fathoms; Butt of the Lewes, 500 fathoms P. (East Atlantic).
ECHINOMETRADÆ, Gray.	
Strongylocentrotus, Br.	
S. dröbachiensis, A. Ag., . . .	British Seas; Spitzbergen; Lofoten Islands, 60 fathoms; North Coast of Siberia; North Sea, 100 fathoms (Arctic).
S. lividus, Br., ...	West Coast of France; British Seas (Atlantic).
Sphærechinus, Des.	
S. granularis, A. Ag., ...	West Coast of France (East Atlantic).
ECHINIDÆ, Agass.	
TRIPLECHINIDÆ, A. Ag.	
Echinus, Rond. (Linn.).	
E. acutus, Lamk., ...	West Coast of France; Irish Sea, 100 fathoms; West Coast of Norway; Shetland Islands, 150 fathoms; Faröe Islands, 400 fathoms (Atlantic; Pacific).
E. elegans, Düb. o. Kor., . . .	South Ireland; West Coast of Norway, 150–250 fathoms; Faröe Islands, 400 fathoms; Valencia, 90 fathoms (Atlantic; Pacific).
E. esculentus, Linn., ...	English Channel; West Coast of Norway, 80 fathoms; Cape North, 15 fathoms (East Atlantic).
E. microstoma, Wy. Thom., . .	West Scotland and Ireland, 150–400 fathoms P.
E. miliaris, Müll., ...	English Channel; West Coast of Norway, 50 fathoms (East Atlantic).
E. norvegicus, Düb. o. Kor., . .	British Seas; North Sea, 200 fathoms; Faröe Islands—Shetland Islands, 400 fathoms P.; Cape Wrath, 300 fathoms P.; West Coast of Norway, 80–450 fathoms (Atlantic; Pacific).
CLYPEASTRIDÆ, Agass.	
EUCLYPEASTRIDÆ, Hæckel.	
FIBULARINA, Gray.	
Echinocyamus, Van Phelps.	
E. pusillus, Gray, ...	British Seas; West Coast Norway, 300 fathoms; Cape North, 15–25 fathoms (North Atlantic).

	Range in Depth and Principal Localities.
PETALOSTICHA, Hæckel.	
CASSIDULIDÆ, Agass.	
NUCLEOLIDÆ, Agass.	
Neolampas, A. Ag.	
N. rostellata, A. Ag., . . .	English Channel, 690 fathoms P. (North Atlantic).
SPATANGIDÆ, Agass.	
POURTALESIÆ, A. Ag.	
Pourtalesia, A. Ag.	
P. jeffreysi, Wy. Thom., . .	Faröe Islands, Shetland Islands, 640 fathoms P.
P. miranda, A. Ag., . . .	Shetland and Faröe Islands; Rockall, 1215 fathoms P. (North Atlantic).
P. phiale, Wy. Thom., . . .	Rockall, 1215 fathoms P. (Antarctic; Atlantic).
SPATANGINA, Gray.	
Spatangus, Kl.	
S. purpureus, Leske., . . .	West Coast of France; West Coast of Norway, 20–40 fathoms (North Atlantic).
S. raschi, Lovén, ...	Shetland and Faröe Islands, 100–300 fathoms P.; Valencia, 110 fathoms P.; West Coast of Norway, 200 fathoms (Atlantic).
Echinocardium, Gray.	
E. cordatum, Gray, . . .	English Channel; West Coast of Norway, 15 fathoms (North Atlantic).
E. flavescens, A. Ag., . . .	English Channel; West Coast of Norway, 20–30 fathoms; Cape North, 40 fathoms; Cape Wrath, 100 fathoms P. (Atlantic).
E. pennatifidum, Norm., . .	Shetland Islands (North Atlantic).
BRISSINA, Gray.	
Brissopsis, Agass.	
B. lyrifera, Agass., . . .	South Ireland, 50–2090 fathoms P.; West Coast Norway (Atlantic).
Schizaster, Agass.	
S. fragilis, Agass., . . .	Shetland—Faröe Islands, 400–500 fathoms P.; West Coast of Norway, 100–150 fathoms (Atlantic).

PORTUGAL—WEST COAST OF TROPICAL AFRICA.

	Range in Depth and Principal Localities.
DESMOSTICHA, Hæckel.	
CIDARIDÆ, Müll.	
GONIOCIDARIDÆ, Hæckel.	
Cidaris, Kl.	
× *C. tribuloides*, Bl., ...	×Cape Verde Islands, 15–20 fathoms; Liberia (Atlantic).
Dorocidaris, A. Ag.	
× *D. papillata*, A. Ag., . . .	Adriatic; Mediterranean; ×Station VIII., 620 fathoms; Cape Sagras, 165 fathoms P. (Atlantic; Pacific).
Porocidaris, Des.	
P. purpurata, Wy. Thom., . .	Cape Espichel.
SALENIDÆ, Agass.	
Salenia, Gray.	
**S. hastigera*, A. Ag., . . .	×Off Macio, 1700 fathoms; ×Bay of Biscay; Coast of Portugal (Pacific).
× *S. varispina*, A. Ag., . . .	×Station 70, 1675 fathoms; ×Stations 73, 78, 1000 fathoms; ×Off Ascension, ×Station 344, 420 fathoms (Atlantic).

	Range in Depth and Principal Localities.
ARBACIADÆ, Gray.	
Arbacia, Gray.	
×*A. pustulosa*, Gray, ...	Madeira; Azores; Liberia; ×St Vincent (Atlantic).
DIADEMATIDÆ, Peters.	
Diadema, Schynv.	
×*D. setosum*, Gray, ...	St Vincent; Canary Islands; Sicily (Atlantic; Pacific).
Centrostephanus, Pet.	
C. longispinus, Pet., ...	Madeira; Sicily.
Aspidodiadema, A. Ag.	
**A. microtuberculatum*, A. Ag., .	×Off Macio, 1700 fathoms (Atlantic; Southern Ocean).
**A. tonsum*, A. Ag., ...	×Off Macio, 1700 fathoms (Indian; Pacific).
ECHINOTHURIDÆ, Wy. Thom.	
Asthenosoma, Grube	
A. fenestratum, Wy. Thom., . .	Bay of Biscay, 445 fathoms P. (?).
A. hystrix, A. Ag., ...	Portugal; Off Vigo (Atlantic).
Phormosoma, Wy. Thom.	
**P. uranus*, Wy. Thom., . . .	×Station VI., 1525 fathoms; ×Station 78, 1000 fathoms (Atlantic).
ECHINOMETRADÆ, Gray.	
Echinometra, Rond. (Breyn.)	
×*E. subangularis*, Desml., . . .	Cape Verde; Azores; Senegal; ×Ascension (Atlantic).
Strongylocentrotus, Br.	
S. lividus, Br., ...	Canary Islands; Azores; Sicily (Atlantic).
Sphærechinus, Des.	
×*S. granularis*, A. Ag., ...	Cape Verde Islands; Azores; Sicily; ×St Vincent; ×Station 75, 450 fathoms.
ECHINIDÆ, Agass.	
TEMNOPLEURIDÆ, Des.	
Temnechinus, Forbes.	
T. maculatus, A. Ag., ...	Josephine Bank, 600 fathoms J. (North Atlantic).
Trigonocidaris, A. Ag.	
T. albida, A. Ag., ...	Josephine Bank, 600 fathoms J. (North Atlantic).
TRIPLECHINIDÆ, A. Ag.	
Echinus, Rond. (Linn.)	
×*E. acutus*, Lamk., ...	Portugal; Sicily; ×Ascension, Station 343, 425 fathoms; Cape Sagras, 165 fathoms, P. (Atlantic; Pacific).
E. elegans, Düb. o. Kor., . .	Cape Sagras, 80 fathoms, P. (Atlantic; Pacific).
E. melo, Lamk., ...	Cape Verde Islands; Sicily; Messina, 35–55 fathoms (East Atlantic).
E. microtuberculatus, Bl., . .	Cape Verde Islands; Sicily (East Atlantic).
CLYPEASTRIDAE, Agass.	
EUCLYPEASTRIDÆ, Hæckel.	
FIBULARINA, Gray.	
Echinocyamus, Van Phels.	
E. pusillus, Gray, ...	Madeira; Azores; Sicily (North Atlantic).

	Range in Depth and Principal Localities.
Echinanthidæ, A. Ag.	
Clypeaster, Lamk.	
C. subdepressus, A. Ag.,	West Coast of Tropical Africa (North Atlantic).
Scutellidæ, Agass.	
Rotula, Kl.	
R. augusti, Kl.,	West Africa; Liberia.
R. rumphii, Kl.,	Cape Verde Islands; Porto Praya, 20 fathoms; Senegal.
PETALOSTICHA, Hæckel.	
Cassidulidæ, Agass.	
Nucleolidæ, Agass.	
Echinolampas, Gray.	
E. hellei, Val.,	Liberia; Senegal.
Spatangidæ, Agass.	
Pourtalesiæ, A. Ag.	
Calymne, Wy. Thom.	
**C. relicta*, Wy. Thom.,	×Fayal, 2650 fathoms.
Ananchytidæ, Alb. Gras.	
Palæotropus, Lov.	
P. josephinæ, Lov.,	Azores, 250 fathoms, J. (North Atlantic).
Homolampas, A. Ag.	
H. fragilis, A. Ag.,	Josephine Bank, 5-600 fathoms, J. (North Atlantic).
Spatangina, Gray.	
Spatangus, Kl.	
× *S. purpureus*, Leske,	Mediterranean; Adriatic; ×Azores, ×Station 75, 50–90 fathoms (North Atlantic).
S. raschi, Lov.,	Azores; Faröe Islands—Gibraltar, 100–300 fathoms, P. (Atlantic).
Echinocardium, Gray.	
E. cordatum, Gray,	Mediterranean (North Atlantic).
E. mediterraneum, Gray,	Mediterranean; Sicily; Messina, 2–20 fathoms.
Brissina, Gray.	
Hemiaster, Des.	
H. expergitus, Lov.,	West Coast of Spain, 485 fathoms, J. (North Atlantic).
**H. zonatus*, A. Ag.,	×Station VIII., 620 fathoms (North Atlantic).
Brissopsis, Agass.	
B. lyrifera, Agass.,	Mediterranean; Sicily (Atlantic).
Aërope, Wy. Thom.	
**A. rostrata*, Wy. Thom.,	×Bay of Biscay and Coast of Portugal (Atlantic; Pacific).
Aceste, Wy. Thom.	
**A. bellidifera*, Wy. Thom.,	×Station VIII., 620 fathoms (Atlantic; Pacific).

	Range in Depth and Principal Localities.
Brissus, Kl.	
**B. damesi*, A. Ag., ...	×Station 75, 450 fathoms (North Atlantic).
B. unicolor, Kl., ...	Cape Verde Islands; Sicily (North Atlantic).
Metalia, Gray.	
M. africana, A. Ag., ...	West Coast Tropical Africa.
M. costæ, Lud., ...	Capri, 25 fathoms.
Schizaster, Agass.	
S. canaliferus, Agass., ...	Mediterranean, 37 fathoms; Sicily.

Cape of Good Hope—Natal.

	Range in Depth and Principal Localities.
DESMOSTICHA, Hæckel.	
Cidaridæ, Müll.	
Goniocidaridæ, Hæckel.	
Cidaris, Kl.	
C. metularia, Bl., ...	(African-Indian-Pacific).
Phyllacanthus, Br.	
P. baculosa, A. Ag., ...	(Indo-African).
P. dubia, Br., ...	(Indo-African).
Goniocidaris, Des.	
G. canaliculata, A. Ag., . . .	(Southern Ocean).
Arbaciadæ, Gray.	
Arbacia, Gray.	
×*A. dufresnii*, Gray, ...	×Nightingale Island (Southern Ocean).
Diadematidæ, Peters.	
Diadema, Schynv.	
D. setosum, Gray, ...	(Atlantic; Pacific).
Echinothrix, Pet.	
E. desorii, Pet., ...	(African-Indian-Pacific).
Echinometradæ, Gray.	
Echinometra, Rond. (Breyn.)	
E. lucunter, Bl., ...	Natal (African-Indian-Pacific).
Stomopneustes, Agass.	
S. variolaris, A. Ag., ...	Natal (Indo-African).
Echinostrephus, A. Ag.	
E. molare, A. Ag., ...	Natal (African-Indian-Pacific).
Echinidæ, Agass.	
Triplechinidæ, A. Ag.	
Echinus, Rond. (Linn.)	
×*E. angulosus*, A. Ag., ...	×Simon's Bay, 10–20 fathoms (African-Indian-Southern Ocean).

	Range in Depth and Principal Localities.
CLYPEASTRIDÆ, Agass.	
SCUTELLIDÆ, Agass.	
Echinodiscus, Breyn.	
E. lævis, A. Ag., ...	(Indian; African).
PETALOSTICHA, Hæckel.	
CASSIDULIDÆ, Agass.	
NUCLEOLIDÆ, Agass.	
Echinolampas. Gray.	
E. oviformis, Gray, . .	(Indo-African).
SPATANGIDÆ, Agass.	
SPATANGINA, Gray.	
Spatangus, Kl.	
⊕*S. raschi*, Lovén, ...	×Station 142, 150 fathoms; ×Agulhas Bank, 100 fathoms (Atlantic).
Lovenia, Des.	
×*L. elongata*, Gray, ...	×Simon's Bay (Indo-African).
Echinocardium, Gray.	
E. australe, Gray, ...	Simon's Bay, 12 fathoms (Indian; Southern Ocean).
⊕*E. flavescens*, A. Ag., . . .	×Station 142, 150 fathoms (Atlantic).
BRISSINA, Gray.	
Brissopsis, Agass.	
⊕*B. lyrifera*, Agass., . . .	×Simon's Bay, 5–18 fathoms; ×Station 141, 98 fathoms; ×Station 142, 150 fathoms; ×Agulhas Bank, 150 fathoms (Atlantic).
Schizaster, Agass.	
⊕*S. fragilis*, Agass., ...	×Station 142, 150 fathoms (Atlantic).

Of the Pacific species at the Cape of Good Hope not hitherto recorded from that locality, the Challenger collected *Lovenia elongata;* but by far the most interesting species collected at the Cape by the Challenger were *Spatangus raschi, Echinocardium flavescens, Brissopsis lyrifera,* and *Schizaster fragilis*, which thus far, are found to be eminently Atlantic species characteristic of the deeper water, and cropping to the surface as in the continental range in Eastern North America, Brazil, West Indies, and Western European seas.

The assemblage of species at the Cape of Good Hope is most peculiar, it is the meeting of the western boundaries of the African-Indian-Pacific and of the Indo-African, the southern boundary of the Atlantic, and the northern extremities of the southern Ocean faunæ, and it has no species characteristic of its own in the continental or abyssal range.

Southern China—Northern Japan.

	Range in Depth and Principal Localities.
DESMOSTICHA, Hæckel.	
Cidaridæ, Müll.	
Goniocidaridæ, Hæckel.	
Cidaris, Kl.	
C. metularia, Bl., ...	South China, 40 fathoms; West Shores Philippines (African-Indian-Pacific).
Dorocidaris, A. Ag.	
⊕*D. papillata*, A. Ag., . . .	×Station 204, 100–115 fathoms (Atlantic).
Phyllacanthus, Br.	
×*P. baculosa*, A. Ag., . . .	×Station 201, 82–102 fathoms; Philippines (Indo-African).
Goniocidaris, Des.	
**G. florigera*, A. Ag., . . .	×Station 204, 100–115 fathoms (Pacific).
Arbaciadæ, Gray.	
Podocidaris, A. Ag.	
**P. prionigera*, A. Ag., . . .	×Station 205, 1050 fathoms (Pacific).
Cœlopleurus, Agass.	
⊕*C. maillardi*, A. Ag., . . .	×Station 201, 82–102 fathoms; Mauritius (Indo-African).
Diadematidæ, Peters.	
Diadema, Schynv.	
D. setosum, Gray, ...	Ousima; Hong Kong (Atlantic; Pacific).
Micropyga, A. Ag.	
**M. microtuberculatum*, A. Ag., .	×Station 204, 100–115 fathoms (Pacific).
Echinothuridæ, Wy. Thom.	
Asthenosoma, Grube	
**A. gracile*, A. Ag., . . .	×Station 200, 255 fathoms (Pacific).
**A. tessellatum*, A. Ag., . . .	×Station 204, 100–115 fathoms.
A. varium, Grube, . . .	China.
Phormosoma, Wy. Thom.	
**P. bursaria*, A. Ag., . . .	×Station 200, 255 fathoms; ×Station 205, 1050 fathoms; ×Station 232, 345 fathoms.
**P. hoplacantha*, Wy. Thom., . .	×Station 235, 565 fathoms (South Pacific).
**P. luculentum*, A. Ag., . . .	×Station 200, 255 fathoms; ×Station 205, 1050 fathoms (Pacific).
**P. tenue*, A. Ag., ...	×Station 237, 1875 fathoms (Pacific).
Echinometradæ, Gray.	
Echinometra, Rond. (Breyn.)	
E. lucunter, Bl., ...	Japan (African-Indian-Pacific).
Strongylocentrotus, Br.	
S. depressus, A. Ag., . . .	Niphon.
S. intermedius, A. Ag., . . .	Ousima; Hakodadi.
S. nudus, A. Ag., ...	Niphon (Pacific).
S. tuberculatus, Br., . . .	China; Yeddo (Indo-Pacific).
Sphærechinus, Des.	
S. pulcherrimus, A. Ag., . . .	China; Hakodadi.

	Range in Depth and Principal Localities.
ECHINIDÆ, Agass.	
TEMNOPLEURIDÆ, Des.	
Temnopleurus, Agass.	
× *T. hardwickii*, A. Ag., ...	Nagasaki; Yeddo; ×Yokohama, 5–25 fathoms; Hakodadi; ×Kobi, 8–52 fathoms (Indian).
T. reynaudi, Agass., . . .	China; North China (Indian).
× *T. toreumaticus*, Agass., . .	China; North China; ×Station 203, 12–20 fathoms (Indo-African).
Pleurechinus, Agass.	
⊕ *P. bothryoides*, Agass., ...	×Kobi; Japan, 8–50 fathoms.
Microcyphus, Agass.	
M. maculatus, Agass., ...	Oosima (Indian).
M. zigzag, Agass., ...	Kagosima (Indian).
Salmacis, Agass.	
S. dussumieri, Agass., ...	China (Indian).
× *S. rarispina*, Agass., . . .	Shanghai; ×Station 203, 12–20 fathoms (Indo-African).
S. sulcata, Agass., . . .	China (Indo-African).
Mespilia, Des.	
M. globulus, Agass., . . .	China; Ousima (Indo-Pacific).
TRIPLECHINIDÆ, A. Ag.	
Phymosoma, Haime.	
P. crenulare, A. Ag., . . .	Hakodadi.
Echinus, Rond. (Linn.)	
⊕ *E. norvegicus*, Düb. o. Kor., . .	×Station 232, 345 fathoms; ×Station 235, (label says) 365 fathoms (Atlantic).
Toxopneustes, Agass.	
T. pileolus, Agass., . . .	Formosa; Japan (African-Indian-Pacific).
Hipponoë, Gray.	
H. variegata, A. Ag., . . .	Ousima (African-Indian-Pacific).
CLYPEASTRIDÆ, Agass.	
EUCLYPEASTRIDÆ, Hæckel.	
FIBULARINA, Gray.	
Fibularia, Lamk.	
F. australis, Desml., . . .	Ousima (Pacific).
F. volva, Agass., ...	Formosa (Indo-African).
ECHINANTHIDÆ, A. Ag.	
Clypeaster, Lamk.	
C. scutiformis, Lamk., . . .	Formosa (African-Indian-Pacific).
Echinanthus, Breyn.	
E. testudinarius, Gray, . . .	Hakodadi (Pacific).
LAGANIDÆ, Des. (emend.).	
Laganum, Kl.	
L. depressum, Less. . . .	Hong Kong (African-Indian-Pacific).
L. putnami, Barn, ...	Formosa; Ousima (Indian).
Peronella, Gray.	
P. decagonalis, A. Ag., . . .	Hong Kong; Japan (Indo-Pacific).

	Range in Depth and Principal Localities.
SCUTELLIDÆ, Agass.	
Echinarachnius, Leske.	
E. mirabilis, A. Ag., ...	Hakodadi.
Echinodiscus, Breyn.	
E. lævis, A. Ag., ...	China Sea, 20 fathoms; Ousima (Indo-African).
Astriclypeus, Verrill.	
×*A. manni*, Verrill, ...	China; Yeddo; ×Inland Sea, Japan.
PETALOSTICHA, Hæckel.	
SPATANGIDÆ, Agass.	
POURTALESIÆ, A. Ag.	
Pourtalesia, A. Ag.	
**P. laguncula*, A. Ag., ...	×Station 232, 345 fathoms (Pacific).
Cystechinus, A. Ag.	
**C. clypeatus*, A. Ag., ...	×Station 205, 1050 fathoms (South Atlantic).
ANANCHYTIDÆ, Alb. Gras.	
Linopneustes, A. Ag.	
**L. murrayi*, A. Ag., ...	×Station 232, 345 fathoms (Pacific).
SPATANGINA, Gray.	
Spatangus, Kl.	
S. lütkeni, A. Ag., ...	Formosa; Hakodadi.
Maretia. Gray.	
M. alta, A. Ag., ...	Kagosima (Indian).
M. planulata, Gray, ...	China (African-Indian-Pacific).
Lovenia, Des.	
×*L. subcarinata*, Gray, ...	China; Hakodadi; ×Hong Kong, 10 fathoms (Indian-Pacific).
Echinocardium, Gray.	
×*E. australe*, Gray, ...	China; Japan; ×Kobi, 8–50 fathoms; ×Station 234, 2675 fathoms (Indian-Southern Ocean).
LESKIADÆ, Gray.	
Palæostoma, Lovén.	
P. mirabilis, Lov., . . .	Hong Kong (Indian).
BRISSINA, Gray.	
Hemiaster, Des.	
**H. gibbosus*, A. Ag., ...	×Station 232, 345 fathoms (Pacific).
Rhinobrissus, A. Ag.	
R. pyramidalis, A. Ag.	China.
Brissopsis, Agass.	
×*B. luzonica*, A. Ag., ...	Formosa; ×Station 203, 12–20 fathoms; ×Station 232, 345 fathoms (Indo-Pacific).
Faorina, Gray.	
F. chinensis, Gray, ...	China; Hong Kong; Shanghai (Pacific?).
Schizaster, Agass.	
**S. japonicus*, A. Ag., ...	×Yokohama, 8–14 fathoms; ×Kobi, Japan, 8–50 fathoms; ×Hong Kong, 10 fathoms; ×Station 233 B., 15 fathoms (Pacific).
×*S. ventricosus*, Gray, ...	Hong Kong; ×Station 232, 345 fathoms (Indo-Pacific).

Of the Japanese and Chinese species *Schizaster japonicus* is the only new littoral species collected by the Challenger. The habitat of *Pleurechinus* is determined for the first time, and *Echinus norvegicus* and *Dorocidaris papillata* are recorded for the first time as coming from the Pacific. As far as the other deep-water species are concerned there are of the continental Indo-African *Cœlopleurus maillardi*, *Micropyga tuberculatum*, while *Podocidaris*, *Phormosoma*, *Asthenosoma*, and *Pourtalesia* are Pacific abyssal, with the exception of *Asthenosoma varium*, and the Japanese representative continental *Linopneustes murrayi* and *Goniocidaris florigera*.

Pacific Ocean.

	Range in Depth and Principal Localities.
DESMOSTICHA, Hæckel.	
CIDARIDÆ, Müll.	
GONIOCIDARIDÆ, Hæckel.	
Cidaris, Kl	
C. metularia, Bl.,	Solomon and Sandwich Islands (African-Indian-Pacific).
Dorocidaris, A. Ag.	
**D. bracteata*, A. Ag.,	×Amboyna, 15–100 fathoms.
⊕*D. papillata*, A. Ag.,	×Station 210, 375 fathoms (Atlantic).
Phyllacanthus, Br.	
×*P. annulifera*, A. Ag.,	South Sea; ×Cape York; ×Station 186, 8 fathoms; ×Station 188, 28 fathoms (Indian).
×*P. baculosa*, A. Ag.,	Samboangan, 10 fathoms (Indo-African).
P. dubia, Br.,	Bonin Islands; New Caledonia (Indo-African).
×*P. gigantea*, A. Ag.,	Sandwich Islands (African-Indian-Pacific).
P. imperialis, Br.,	Tonga (African-Indian-Pacific).
×*P. verticillata*, A. Ag.,	Navigator Islands; Society Islands; Sandwich Islands; ×Station 186, 8 fathoms (African-Indian-Pacific).
Porocidaris, Des.	
**P. elegans*, A. Ag.,	×Station 214, 500 fathoms.
Goniocidaris, Des.	
G. canaliculata, A. Ag.,	Caroline and Sandwich Islands (Southern Ocean).
**G. florigera*, A. Ag.,	×Station 192, 129 fathoms.
SALENIDÆ, Agass.	
Salenia, Gray.	
**S. hastigera*, A. Ag.,	×Station 170, 630 fathoms; ×Station 171, 600 fathoms; ×Station 195, 1425 fathoms; ×Off Cebu, 100 fathoms (Atlantic).
ARBACIADÆ, Gray.	
Podocidaris, A. Ag.	
**P. prionigera*, A. Ag.,	×Station 218, 1070 fathoms.
Cœlopleurus, Agass.	
⊕*C. maillardi*, A. Ag.,	×Station 192, 129 fathoms; ×Amboyna, 100 fathoms (Indo-African).

	Range in Depth and Principal Localities.
DIADEMATIDÆ, Peters.	
Diadema, Schynv.	
×*D. setosum*, Gray,	Fiji Islands; Sandwich Islands; ×Cebu; ×Papeete Reef (Atlantic; Pacific).
Centrostephanus, Pet.	
C. rodgersii, A. Ag.,	New Caledonia (Australian).
Aspidodiadema, A. Ag.	
**A. tonsum*, A. Ag.,	×Off Cebu, 100 fathoms; ×Station 170, 630 fathoms; ×Station 171, 600 fathoms.
Echinothrix, Pet.	
×*E. calamaris*, A. Ag.,	Society Islands; ×Kandavu Reef; ×Cebu; ×Tahiti.
E. desorii, Pet.,	Fiji Islands (African-Indian-Pacific).
×*E. turcarum*, Pet.,	Bonin, Navigator, and Sandwich Islands; ×Kandavu Reef (African; Indian; Pacific).
Micropyga, A. Ag.	
**M. tuberculatum*, A. Ag.,	×Station 174, 610 fathoms; ×Station 219, 150 fathoms; ×Off Cebu, 100 fathoms.
Astropyga, Gray.	
A. elastica, Stud.,	New Britain, 20 fathoms.
⊕*A. pulvinata*, Agass.,	×Station 188, 28 fathoms; ×Station 190, 49 fathoms; ×Honolulu, 18 fathoms (Panama).
ECHINOTHURIDÆ, Wy. Thom.	
Asthenosoma, Grube.	
**A. coriaceum*, A. Ag.,	×Station 172, 240 fathoms; ×Station 173, 310–315 fathoms.
**A. gracile*, A. Ag.,	×Station 169, 700 fathoms; ×Station 184, 1400 fathoms; ×Station 219, 150 fathoms.
**A. grubii*, A. Ag.,	×Samboangan, 10 fathoms.
**A. pellucidum*, A. Ag.,	×Off Cebu, 100 fathoms; ×Station 192, 129 fathoms.
Phormosoma, Wy. Thom.	
**P. luculentum*, A. Ag.,	×Station 191, 800 fathoms.
**P. tenue*, A. Ag.,	×Station 272, 2600 fathoms; ×Station 274, 2750 fathoms.
ECHINOMETRADÆ, Gray.	
Colobocentrotus, Br.	
C. atratus, Br.,	Sandwich Islands (African-Indian-Pacific).
C. mertensii, Br.,	Bonin Islands.
Heterocentrotus, Br.	
×*H. mammillatus*, Br.,	Fiji Islands; Sandwich Islands; ×Kandavu Reef (African-Indian-Pacific).
×*H. trigonarius*, Br.,	New Caledonia; Sandwich Islands (African-Indian-Pacific).
Echinometra, Rond. (Breyn.).	
×*E. lucunter*, Bl.,	New Caledonia, Loo Choo; Sandwich Islands; ×Samboangan, 10 fathoms; ×Kandavu Reef; ×Off Cebu; ×Papeete Reef; ×Tongatabu, 18 fathoms (African; Indian; Pacific).
E. oblonga, Bl.,	Solomon and Sandwich Islands.
Parasalenia, A. Ag.	
P. gratiosa, A. Ag.,	Bonin Islands; New Caledonia; Sandwich Islands (African-Indian-Pacific).
Stomopneustes, Agass.	
S. variolaris, Agass.,	Navigator Islands (Indo-African).

	Range in Depth and Principal Localities.
Strongylocentrotus, Br.	
⊕*S. eurythrogrammus*, A. Ag., . .	×New Caledonia (Australian).
S. gibbosus, A. Ag., ...	Fiji Islands; Galapagos (Chilian).
S. nudus, A. Ag., ...	Sandwich Islands; Galapagos (Indian).
S. tuberculatus, Br., ...	South Sea (African; Australian).
Sphærechinus, Des.	
S. australiæ, A. Ag., ...	South Sea; Fiji Islands (Australian).
Pseudoboletia, Trosch.	
P. granulata, A. Ag., ...	Sandwich Islands.
⊕*P. indiana*, A. Ag., ...	×Samboangan, 10 fathoms (Indo-African).
Echinostrephus, A. Ag.	
E. molare, A. Ag., ...	Kingsmills; Society and Sandwich Islands (African-Indian-Pacific).
ECHINIDÆ, Agass.	
TEMNOPLEURIDÆ, Des.	
Temnopleurus, Agass.	
×*T. hardwickii*, A. Ag., ...	×Arafura Sea; ×Station 192, 129 fathoms (Indian)
×*T. reynaudi*, Agass., ...	×Station 219, 150 fathoms; ×Station 192, 129 fathoms (Indian).
T. toreumaticus, Agass., . . .	New Caledonia (Indo-African).
Pleurechinus, Agass.	
⊕*P. bothryoides*, Agass., ...	×Station 186, 8 fathoms (Galapagos ?).
Prionechinus, A. Ag.	
**P. sagittiger*, A. Ag., ...	×Station 207, 700 fathoms; ×Station 218, 1070 fathoms.
Cottaldia, Des.	
**C. forbesiana*, A. Ag., ...	×Station 173, 310–315 fathoms.
Microcyphus, Agass.	
M. maculatus, Agass., ...	South Pacific; Navigator Islands (Indian).
Trigonocidaris, A. Ag.	
**T. monolini*, A. Ag., ...	×Station 170, 520 fathoms.
Salmacis, Agass.	
×*S. bicolor*, Agass., ...	×Samboangan, 10 fathoms (Indo-African).
×*S. dussumieri*, Agass., ...	×Amboyna, 100 fathoms; ×Station 212, 10–20 fathoms (Indian).
×*S. globator*, Agass., ...	×Station 186, 8 fathoms (Indian).
×*S. rarispina*, Agass., ...	×Station 186, 8 fathoms; ×Station 188, 28 fathoms (Indo-African).
×*S. sulcata*, Agass., ...	×Off Cebu (Indo-African).
Mespilia, Des.	
×*M. globulus*, Agass., ...	Sandwich Islands; Navigator Islands; Tonga; ×Samboangan, 10 fathoms (Indian-Pacific).
Amblypneustes, Agass.	
A. pallidus, Val., ...	Fiji Islands (Australian).
TRIPLECHINIDÆ, A. Ag.	
Echinus, Rond. (Linn.).	
⊕*E. acutus*, Lamk., ...	×Station 170, 630 fathoms (Atlantic).
⊕*E. elegans*, Düb. o. Kor., . . .	×Station 219, 150 fathoms (Atlantic).
Toxopneustes, Agass.	
T. maculatus, A. Ag., ...	Fiji Islands; Christmas Island.
×*T. pileolus*, Agass., ...	Navigator Islands; Fiji Islands; ×Honolulu; ×Samboangan, 10 fathoms (African-Indian-Pacific).

	Range in Depth and Principal Localities.
Hipponoë, Gray.	
×*H. variegata*, A. Ag., ...	Pelew; Fiji and Sandwich Islands; ×Samboangan, 10 fathoms; ×Kandavu (African-Indian-Pacific).
Evechinus, Verrill.	
×*E. chloroticus*, Verrill., ...	Christmas Island; ×Kandavu Reef (Australian).
CLYPEASTRIDÆ, Agass.	
EUCLYPEASTRIDÆ, Hæckel.	
FIBULARINA, Gray.	
Fibularia, Lamk.	
F. australis, Desml., ...	Sandwich Islands; South Sea.
×*F. volva*, Agass., ...	Kingsmills Islands; ×Station 188, 28 fathoms (Indo-African).
ECHINANTHIDÆ, A. Ag.	
Clypeaster, Lamk.	
×*C. humilis*, A. Ag., . .	New Caledonia; ×Station 212, 10–20 fathoms; ×Amboyna, 15–20 fathoms (Indo-African).
×*C. scutiformis*, Lamk., ...	Kingsmills Islands; Sandwich Islands; ×New Caledonia (African-Indian-Pacific).
Echinanthus, Breyn.	
E. testudinarius, Gray, ...	Sandwich Islands.
LAGANIDÆ, Des. (emend.).	
Laganum, Kl.	
L. bonani, Kl., ...	Pelew Islands (Indian).
×*L. depressum*, Less., ...	South Pacific; ×Arafura Sea; Fiji and Sandwich Islands; ×Station 187, 6 fathoms (African-Indian-Pacific).
⊕*L. putnami*, Barn., ...	×Amboyna, 15–25 fathoms (Indian).
Peronella, Gray.	
×*P. decagonalis*, A. Ag., . . .	New Caledonia; ×Gaspar Straits, 12 fathoms; ×Amboyna, 15–20 fathoms; ×Tongatabu; ×Tahiti, 20 fathoms; ×Torres Straits; ×Station 173, 310–315 fathoms; ×Station 186, 8 fathoms; ×Station 188, 28 fathoms; ×Station 190, 49 fathoms; ×Station 192, 129 fathoms; ×Station 208, 18 fathoms; ×Station 212, 10–20 fathoms; ×Station 219, 150 fathoms (Indian-Pacific).
SCUTELLIDÆ, Agass.	
Arachnoides, Kl.	
A. placenta, Agass., ...	South Sea; Solomon Islands (Indian; Australian).
Echinodiscus, Breyn.	
×*E. lævis*, A. Ag., ...	New Caledonia (Indo-African).
PETALOSTICHA, Hæckel.	
CASSIDULIDÆ, Agass.	
ECHINONIDÆ, Agass.	
Echinonëus, Van Phel.	
E. cyclostomus, Leske, ...	Navigator, Kingsmills, and Sandwich Islands (African-Indian-Pacific).
Echinolampas, Gray.	
×*E. oviformis*, Gray, ...	×Station 192, 129 fathoms (Indo-African).
Catopygus, Agass.	
C. recens, A. Ag., ...	×Station 192, 129 fathoms.
Nucleolites, Lamk.	
N. epigonus, Mart., ...	Lord Hood's Island (Indian).

	Range in Depth and Principal Localities.
SPATANGIDÆ, Agass.	
POURTALESIÆ, A. Ag.	
Pourtalesia, A. Ag.	
✱*P. laguncula*, A. Ag., ...	×Station 191, 800 fathoms; ×Station 244, 2900 fathoms.
✱*P. rosea*, A. Ag., ...	×Station 272, 2600 fathoms.
ANANCHYTIDÆ, Alb. Gras.	
Palæotropus, Lov.	
✱*P. loveni*, A. Ag., ...	×Station 210, 375 fathoms.
Argopatagus, A. Ag.	
✱*A. vitreus*, A. Ag., ...	×Station 191, 800 fathoms.
Homolampas, A. Ag.	
✱*H. fulva*, A. Ag., ...	×Station 271, 2425 fathoms.
Linopneustes, A. Ag.	
✱*L. murrayi*, A. Ag., ...	×Station 210, 375 fathoms.
SPATANGINA, Gray.	
Maretia, Gray.	
⊕*M. alta*, A. Ag., ...	×Station 191, 800 fathoms; ×Station 192, 129 fathoms (Indian).
×*M. planulata*, Gray, ...	Kingsmills Islands; New Caledonia; ×Admiralty Islands, 16–25 fathoms; ×Levuka Reef (African-Indian-Pacific).
Eupatagus, Agass.	
⊕*E. valenciennesii*, Agass., . .	×Station 188, 28 fathoms; ×Arafura Sea (Australian).
Lovenia, Des.	
×*L. elongata*, Gray, ...	×Station 188, 28 fathoms; ×Station 212, 10–20 fathoms (Indo-African).
L. subcarinata, Gray, ...	Sandwich Islands (Indian-Pacific).
Breynia, Des.	
B. australasiæ, Gray, ...	Sandwich Islands; ×Torres Straits (Indo-African).
BRISSINA, Gray.	
Hemiaster, Des.	
✱*H. gibbosus*, A. Ag., ...	×Station 191, 800 fathoms.
Rhinobrissus, A. Ag.	
✱*R. hemiasteroides*, A. Ag., . .	×Tahiti, 20 fathoms.
Cionobrissus, A. Ag.	
✱*C. revinctus*, A. Ag., ...	×Station 191, 800 fathoms.
Brissopsis, Agass.	
×*B. luzonica*, A. Ag., ...	New Caledonia; ×Tahiti Harbour; ×Station 188, 28 fathoms; ×Station 191, 800 fathoms (Indian-Pacific).
Aërope, Wy. Thom.	
✱*A. rostrata*, Wy. Thom., . .	×Station 191, 800 fathoms.
Aceste, Wy. Thom.	
✱*A. bellidifera*, Wy. Thom., . .	×Station 272, 2600 fathoms.
Brissus, Kl.	
B. carinatus, Gray, ...	Pelew, Fiji, Society and Sandwich Islands (African-Indian-Pacific).

	Range in Depth and Principal Localities.
Metalia, Gray.	
×*M. maculosa*, A. Ag., . . .	Kingsmills, Navigator, Society, and Sandwich Islands; ×Station 188, 28 fathoms (African-Indian-Pacific).
M. sternalis, Gray, . . .	New Caledonia, Navigator, Society, and Sandwich Islands (African-Indian-Pacific).
Linthia, Mer.	
L. rostrata, Smith, . . .	Pacific Islands.
Faorina, Gray.	
F. chinensis, Gray, . . .	Sandwich Islands.
Schizaster, Agass.	
S. japonicus, A. Ag., . . .	×Station 188, 28 fathoms.
S. ventricosus, Gray, . . .	Pelew and Fiji Islands (Indian-Pacific).
Periaster, D'Orb.	
⊕*P. limicola*, A. Ag., . . .	×Station 188, 28 fathoms (Atlantic).
Moiropsis, A. Ag.	
**M. claudicans*, A. Ag., . . .	×Station 192, 129 fathoms.

The list of species marked here as Pacific includes not only the strictly littoral Pacific species, but also the Indo-Pacific species, and such Indo-African species as encroach to the eastward upon the southern boundary of the Chinese and Japanese districts, the westward boundary of the Pacific, and the northern limits of the Australian realm.

Of the species collected by the Challenger there have only been found among the littoral species *Rhinobrissus hemiasteroides*, *Schizaster japonicus* and *Moiropsis claudicans* which were not previously known. Of these *Schizaster japonicus* is probably a Japanese and Chinese species, while *Moiropsis claudicans*, and perhaps *Schizaster japonicus* may be East Indian species which find their south-eastern limits at the western edge of the Pacific district.

The range of *Astropyga pulvinata*, *Brissopsis luzonica*, *Strongylocentrotus eurythogrammus* (an Australian species), of *Cœlopleurus maillardi* (an East Indian species), of *Pleurechinus bothyryoides*, *Pseudoboletia indiana*, *Salmacis dussumieri*, *S. globator* (Australian), *Salmacis rarispina* (Indian), *Evechinus chloroticus* (a New Zealand species), *Laganum putnami*, *Maretia alta*, *Temnopleurus hardwicki*, *Temnopleurus reynaudi* (Japan and China species), *Lovenia elongata* (Sandwich Islands), and *Metalia maculosa* have been greatly extended, while *Echinus acutus* is another eminently Atlantic species which has found its way far into the Pacific to the Kermadec Islands, and *Dorocidaris papillata* and *Echinus elegans* to the Philippine Islands.

As probably representative continental species of the Pacific we must class *Dorocidaris bracteata*, *Asthenosoma gracile*, *A. pellucidum*, *A. grubii*, *Catopygus recens*, and *Linopneustes murrayi*; as probably continental representatives of the East Indian fauna, *Cottaldia forbesiana*, *Podocidaris prionigera*, and *Micropyga tuberculata*; of

the continental Australian *Goniocidaris florigera*, and perhaps of the Southern Ocean *Porocidaris elegans*.

While of the abyssal species common to the Atlantic and Pacific we have *Salenia hastigera*, *Aspidodiadema tonsum*, *Aërope rostrata*, *Periaster limicola*, and *Aceste bellidifera*.

As strictly Pacific representative abyssal species we can enumerate *Asthenosoma coriaceum*, *Phormosoma tenue*, *Phormosoma luculentum*, *Phormosoma bursaria*, *Trigonocidaris monilini*, *Prionechinus sagittiger*, *Paleotropus loveni*, *Pourtalesia laguncula*, *Pourtalesia rosea*, *Homolampas fulva*, *Cionobrissus revinctus*, and *Argopatagus vitreus*, the Southern Ocean species extending only into the southern part of the Pacific, as in the Atlantic, in the South American, and Australian districts, but a greater number of species than we find going northward in the Atlantic.

West, South, East, and North-East Australia—New Zealand.

	Range in Depth and Principal Localities.
DESMOSTICHA, Hæckel.	
CIDARIDÆ, Müll.	
GONIOCIDARIDÆ, Hæckel.	
Phyllacanthus, Br.	
P. annulifera, A. Ag.,	South Sea (Indo-Pacific).
P. dubia, Br.,	Australia (Indo-African).
P. imperialis, Br.,	Australia (African-Indian-Pacific).
P. verticillata, A. Ag.,	South Sea (African-Indian-Pacific).
Stephanocidaris, A. Ag.	
S. bispinosa, A. Ag.,	Australia (Indian).
Porocidaris, Des.	
**P. elegans*, A. Ag.,	×Station 164*a*, 410 fathoms (Pacific).
Goniocidaris, Des.	
G. geranioides, Agass.,	Murray River; West Australia (Indian).
× *G. tubaria*, Lütk.,	Bass Straits; Tasmania; ×Station 161, 38 fathoms; ×Station 162, 38–40 fathoms.
ARBACIADÆ, Gray.	
Arbacia, Gray.	
A. australis, Trosch,	Australia.
DIADEMATIDÆ, Peters.	
Centrostephanus, Pet.	
C. rodgersii, A. Ag.,	Sydney; Houtman's Abrolhos.
ECHINOTHURIDÆ, Wy. Thom.	
Phormosoma, Wy. Thom.	
**P. hoplacantha*, Wy. Thom.,	×Station 164*a*, 410 fathoms (Southern Ocean).
**P. rigidum*, A. Ag.,	×Station 169, 700 fathoms (Southern Ocean).

	Range in Depth and Principal Localities.
ECHINOMETRADÆ, Gray.	
Echinometra, Rondel. (Breyn.).	
E. lucunter, Bl., ...	North Australia; Houtman's Abrolhos (African-Indian-Pacific).
Strongylocentrotus, Br.	
S. armiger, A. Ag., ...	Australia.
×*S. eurythrogrammus*, A. Ag., . .	North Australia; New Zealand; Murray River; ×Sydney, 6–15, 30–35 fathoms.
S. tuberculatus, Br., ...	Sydney (Indo-Pacific).
Sphærechinus, Des.	
×*S. australiæ*, A. Ag., ...	New Zealand; East Australia; Adelaide; ×Station 162, 38–40 fathoms (African).
ECHINIDÆ, Agass.	
TEMNOPLEURIDÆ, Des.	
Temnopleurus, Agass.	
⊕*T. reynaudi*, Agass., ...	×Station 166, 275 fathoms (Indian).
Prionechinus, A. Ag.	
**P. sagittiger*, A. Ag., ...	×Station 164, 950 fathoms (Pacific).
Microcyphus, Agass.	
M. maculatus, Agass., ...	Tasmania; West Australia (Indian).
×*M. zigzag*, Agass., ...	Australia; ×Station 161, 38 fathoms; ×Station 162, 38–40 fathoms (Indian).
Salmacis, Agass.	
S. globator, Agass., ...	Australia (Indian).
S. rarispina, Agass., ...	Cape York (Indo-African).
S. sulcata, Agass., ...	Port Mackay (Indo-African).
Amblypneustes, Agass.	
×*A. formosus*, Val., ...	Tasmania; Adelaide; ×Station 162, 38–40 fathoms.
A. griseus, Agass., ...	New Zealand; Sydney; Adelaide.
A. ovum, Agass., ...	Sydney; Port Lincoln.
A. pallidus, Val., ...	Port Philip; Adelaide.
Holopneustes, Agass.	
H. inflatus, A. Ag., ...	East Australia; New Zealand.
H. porosissimus, Agass., . . .	Australia.
×*H. purpurescens*, A. Ag., . . .	Australia; Tasmania; Murray River; ×Port Jackson, 6–15 fathoms.
TRIPLECHINIDÆ, A. Ag.	
Echinus, Rond. (Linn.).	
E. albocinctus, Hutt., ...	New Zealand.
E. angulosus, A. Ag., ...	New Zealand; Adelaide (African-Indian-Southern Ocean).
E. darleyensis, Wood, ...	Australia.
E. elevatus, Hutt., ...	New Zealand.
E. magellanicus, Phil., ...	New Zealand; Australia (Southern Ocean).
E. margaritaceus, Lam., . . .	South Sea; New Zealand (Southern Ocean).
Hipponoë, Gray.	
⊕*H. variegata*, A. Ag., ...	×Port Jackson, 6–15 fathoms (African-Indian-Pacific).
Evechinus, Verrill.	
E. chloroticus, Verrill, ...	New Zealand.

	Range in Depth and Principal Localities.
CLYPEASTRIDÆ, Agass.	
EUCLYPEASTRIDÆ, Hæckel.	
FIBULARINA, Gray.	
Fibularia, Lamk.	
×*F. australis*, Desml., ...	Coral Sea; ×Port Jackson, 30–35 fathoms; ×Station 164–950 fathoms (Pacific).
F. volva, Agass., ...	North Australia (Indo-African).
ECHINANTHIDÆ, A. Ag.	
Echinanthus, Breyn.	
×*E. testudinarius*, Gray, . . .	Australia; ×Station 161, 38 fathoms; ×Station 163, 120 fathoms (Pacific).
LAGANIDÆ, Des. (emend.).	
Laganum, Kl.	
L. bonani, Kl., ...	Tasmania; Australia (Indian).
L. depressum, Less., . . .	Australia (African-Indian-Pacific).
L. putnami, Barn., . . .	Australia (Indian).
Peronella, Gray.	
P. decagonalis, A. Ag., . . .	West Australia (Indo-Pacific).
×*P. peronii*, Gray, ...	Brisbane Water; Tasmania; ×Station 162, 38–40 fathoms; ×Port Jackson, 30–35 fathoms (Indian).
P. rostrata, A. Ag., . . .	New Zealand (Indo-African?).
PETALOSTICHA, Hæckel.	
CASSIDULIDÆ, Agass.	
NUCLEOLIDÆ, Agass.	
Echinobrissus, Breyn.	
E. recens, D'Orb., . . .	New Zealand (Indo-African).
SPATANGIDÆ, Agass.	
POURTALESIÆ, A. Ag.	
Pourtalesia, A. Ag.	
**P. laguncula*, A. Ag., . . .	×Station 168, 1100 fathoms; ×Station 169, 700 fathoms (Pacific).
SPATANGINA, Gray.	
Maretia, Gray.	
⊕*M. planulata*, Gray, . . .	×Port Jackson, 6–15 fathoms (African-Indian-Pacific).
Eupatagus, Agass.	
×*E. valenciennesii*, Agass., . .	Port Dalrymple; Tasmania; ×Port Jackson, 30–35 fathoms.
Lovenia, Des.	
L. elongata, Gray, . . .	Port Dalrymple; West Australia (Indo-African).
Breynia, Des.	
⊕*B. australasiæ*, Gray, . . .	South Sea; Sydney; West Australia; ×Torres Straits (Indo-African).
Echinocardium, Gray.	
×*E. australe*, Gray, ...	New Zealand; West Australia; ×Port Jackson, 6–15 fathoms (Indian-Southern Ocean).
BRISSINA, Gray.	
Brissopsis, Agass.	
×*B. luzonica*, A. Ag., . . .	×Station 168, 100 fathoms (Indian-Pacific).
Metalia, Gray.	
M. sternalis, Gray, . . .	North Australia; Sydney; New Zealand (African-Indian-Pacific).
Linthia, Mer.	
L. australis, A. Ag., . . .	Flinders Island; Tasmania.

The northern and western boundaries of the Australian district encroach into the Indo-African limits, while the eastern extension of the Australian district laps far into the Pacific, or rather the whole of the Australian field seems to be cut out of the Indo-Pacific realm.[1] We find encroaching into the south-eastern limits abyssal species from the extension of the Pacific abyssal fauna: *Phormosoma hoplacantha*, *Porocidaris elegans*, and *Pourtalesia laguncula*, while *Prionechinus sagittiger* is probably only an abyssal species characteristic of the Indo-African realm.

Of the littoral species already known, *Temnopleurus reynaudi*, *Hipponoë variegata*, *Maretia planulata*, and *Brissopsis luzonica* were found by the Challenger to extend far into the Australian littoral district.

Antarctic and Southern Ocean.

	Range in Depth and Principal Localities.
DESMOSTICHA. Hæckel.	
Cidaridæ, Müll.	
Goniocidaridæ, Hæckel.	
Goniocidaris, Des.	
×*G. canaliculata*, A. Ag.,	×Station 147, 1600 fathoms; ×Station 149, 25 fathoms; ×Kerguelen, 20–150 fathoms.
Arbaciadæ, Gray.	
Arbacia, Gray.	
×*A dufresnii*, Gray,	×Nightingale Islands, 100–150 fathoms; ×Station 151, 75 fathoms; ×Station 153, 1675 fathoms; ×Station 156, 1975 fathoms (South America).
Echinidæ, Agass.	
Triplechinidæ, A. Ag.	
Echinus, Rond. (Linn.)	
×*E. magellanicus*, Phil.,	×Station 145, 150–310 fathoms; ×Station 147, 1600 fathoms; ×Marion Island, 50 fathoms.
×*E. margaritaceus*, Lam.,	×Christmas Harbour, 50–120 fathoms; ×Station 150, 150 fathoms; ×Station 151, 75 fathoms.
PETALOSTICHA, Hæckel.	
Spatangidæ, Agass	
Pourtalesiæ, A. Ag.	
Pourtalesia, A. Ag.	
**P. carinata*, A. Ag.,	×Station 147, 1600 fathoms; ×Station 157, 1950 fathoms (South Pacific).
**P. ceratopyga*, A. Ag.,	×Station 157, 1950 fathoms (South Pacific).
**P. hispida*, A. Ag.,	×Station 147, 1600 fathoms; ×Station 156, 1975 fathoms (Southern Ocean).
×*P. phiale*, Wy. Thom.,	×Station 156, 1975 fathoms (Atlantic).
Spatagocystis, A. Ag.	
**S. challengeri*, A. Ag.,	×Station 147, 1600 fathoms; ×Station 157, 1950 fathoms.
Echinocrepis, A. Ag.	
**E. cuneata*, A. Ag.,	×Station 147, 1600 fathoms.

[1] A number of Indo-African species extending into the Australian realm and into the Chinese districts have been added to the list, as no list of Indo-African species is given.

	Range in Depth and Principal Localities.
Urechinus, A. Ag.	
**U. naresianus*, A. Ag., ...	×Station 146, 1375 fathoms; ×Station 147, 1600 fathoms; ×Station 158, 1800 fathoms (South Pacific).
Cystechinus, A. Ag.	
**C. vesica*, A. Ag., ...	×Station 153, 1675 fathoms (South Pacific).
**C. wyvillii*, A. Ag., ...	×Station 146, 1375 fathoms; ×Station 147, 1600 fathoms; ×Station 158, 1800 fathoms (South Pacific).
ANANCHYTIDÆ, Alb. Gras.	
Genicopatagus, A. Ag.	
**G. affinis*, A. Ag., ...	×Station 157, 1950 fathoms.
BRISSINA, Gray.	
Hemiaster, Des.	
×*H. cavernosus*, A. Ag., ...	×Kerguelen Islands, 10–250 fathoms; ×Heard Island, Station 151, 75 fathoms.
Schizaster, Agass.	
**S. moseleyi*, A. Ag., ...	×Station 146, 1375 fathoms; ×Christmas Harbour, 120 fathoms; Kerguelen Islands, 110 fathoms.

We find extending into the Southern Ocean, that most characteristic of the abyssal realms, *Goniocidaris canaliculata* and *Hemiaster cavernosus*, or, perhaps better, we find them cropping out at the Cape, Australia, and the southern extremity of South America; along with *Echinus magellanicus* and *Echinus margaritaceus*. The only new littoral species is *Schizaster moseleyi*, while it is interesting to find that all the other deep-sea species belong without exception to the Pourtalesiæ. Of the deep-sea species *Pourtalesia phiale* is the only one which finds its way into the northern Atlantic as far as Europe in deep water. A comparatively large number of species of Antarctic Pourtalesiæ and South Pacific Echinothuridæ find their way northward into the Pacific.

EXPLANATION OF THE PLATES.

With the exception of Pls. XIII., XIX.[a], XXVII., and XXVIII., which were drawn on stone by Mr A. Sonrel, of Pls. X.[a], X.[b], XIX., XXIX., XLIV., XLV., drawn by Mr Trouvelot, and Pls. XXXVI., XXXVII., XLII., and XLIII., drawn by Mr Meisel, the other plates were all lithographed by Mr Paulus Roetter, who had gained considerable experience in drawing Echinids while making the plates of the Revision of the Echini. The general views were drawn by him directly on stone from nature; the greater part of the structural drawings were copies of sketches which I made myself to illustrate the details of parts to be seen only from preparations of the test. The greater number of the figures of Pedicellariæ, drawn on stone by Mr Meisel and by Mr Trouvelot, were drawn by myself, with the exception of some drawings on the plates of Pedicellariæ, and of the sections of spines, drawn from nature by Mr James H. Blake. The sections of spines were made by Mr A. A. Julien, of the Columbia School of Mines.

PLATE I.

Cidaris (*Dorocidaris*) *bracteata*, A. Ag. (fig. 1), p. 37.

Fig. 1. Primary radiole.

Cidaris tribuloides, Bl. (figs. 2–6), p. 36.

,, 2. Small specimen of *Cidaris tribuloides*, measuring 18 mm. in diameter, in which the radioles have the shape characteristic of *Phyllacanthus verticillata*.

,, 3. A single primary radiole magnified ($\frac{4}{1}$).

,, 5. A smooth primary radiole similar to those of the lower side of the test in *Cidaris tribuloides* ($\frac{4}{1}$).

,, 6. Another primary radiole, in which the verticillation is not so marked as in fig. 3 ($\frac{3}{1}$).

Goniocidaris florigera, A. Ag. (figs. 7–20), p. 46.

,, 7. A specimen (n.s.) seen from the abactinal side, in which the spines are all of the shape of figs. 8–11, and quite uniform in their appearance.

,, 8, 9. Primary radioles, with sharp spines of fig. 7.

Fig. 10. Smooth radiole of actinal side.
„ 11. Small radiole surrounding the actinostome.
„ 12. Specimen of *Goniocidaris florigera*, in which the primary radioles present the usual variation of the tip, especially on the abactinal surface, characteristic of the genus; natural size.
„ 12 *a*. Abactinal area of the same species, partly denuded; magnified.
„ 13. Portion of denuded test of the same species, facing the median line of an ambulacral area; magnified.
„ 14. Portion of an interambulacral area of same, from the equatorial zone of test.
„ 15 *a*, *b*. The cupuliform radioles of the abactinal region are seen from above, represented in profile in *c*, *d*. ($\frac{2}{1}$).
„ 16 *a*, *b*. End view and profile of a different cupuliform radiole, 15 and 16 are taken from the abactinal region of the test, the principal primary radioles of fig. 12 are cylindrical (fig. 18), with prominent irregularly-arranged spines scattered over the shaft.
„ 17. Small radiole of actinal side of test, near the actinostome ($\frac{3}{1}$).
„ 18. Basal part of shaft of primary cylindrical radioles.
„ 19. Primary radiole near actinal edge of test.
„ 20. Tapering spiniferous radiole, similar to those of fig. 7, taken from specimen of fig. 12.

PLATE II.

Goniocidaris canaliculata, A. Ag. (figs. 1–18), p. 43.

Fig. 1. Specimen with long spines, seen from the abactinal side; natural size.
„ 2. Specimen with short spines, seen from the abactinal side, showing the mode of carrying the young; natural size.
„ 3. Another specimen, with proportionately shorter spines, seen from the actinal side; natural size.
„ 4, 5, 6. Portions of the median interambulacral primary plates, to show the variation in the depth of the median interambulacral groove, from a deep broad groove (fig. 4), to a mere indistinct bare space in fig. 5.
„ 7. Edge of abactinal membrane to show the deep indentation of the median interambulacral and ambulacral spaces of the test.
„ 8. Young specimen, 3 mm. in diameter, seen from the actinal side, denuded of spines about in the stage of fig. 12.
„ 9. Young specimen, seen from the actinal side, 2 mm. in diameter.
„ 10. The same as fig. 9, seen from the abactinal side.

Fig. 12. (This fig. should have been 11). Another young specimen, 3 mm. in diameter, seen from the abactinal side (same as fig. 8). The abactinal spines are larger than in fig. 10.
„ 12, 13. Spines of figs. 9, 10; magnified.
„ 14. Primary spines of fig. 1; magnified.
„ 15. Pedicellaria from the abactinal region of test.
„ 16. Pedicellariæ of test, in different stages of development.
„ 17. Same kind of pedicellariæ as fig. 16, fully developed.
„ 18. Profile view of large terminal abactinal tentacle of young specimens, figs. 9, 10.

PLATE III.

Porocidaris elegans, A. Ag. (figs. 1–12), p. 40.

Fig. 1. Specimen with spines, seen from the abactinal side ($\frac{1}{1}$).
„ 2. Specimen denuded, seen from the abactinal side ($\frac{1}{1}$).
„ 3. The same, from the actinostome.
„ 4. Abactinal area of another specimen, 28 mm. in diameter, probably a male with smaller genital opening.
„ 5. A magnified portion of the test, facing the median interambulacral line near the equatorial region of the test.
„ 6. A magnified portion of the test, facing the median ambulacral line.
„ 7. Magnified view of primary radiole.
„ 8 *a*. A curved serrated radiole of actinal side of test ($\frac{6}{1}$), adjoining actinostome, seen in profile. *b*. The same, seen from the flat side.
„ 9 *a*, *b*. Other small straight radioles, near actinostome ($\frac{5}{1}$).
„ 10. Long slender tridactyle pedicellaria (4 mm.), from abactinal region of test.
„ 11. Another pedicellaria, somewhat more blunt than preceding fig., with coarse pigment spots.
„ 12. Similar to preceding pedicellaria, with finer rows of pigment spots.
Figs. 11 and 12 are drawn on the same scale as fig. 10.

PLATE IV.

Salenia varispina, A. Ag. (figs. 1, 2), p. 55.

Fig. 1. Portion of test of *Salenia varispina*, facing the median interambulacral space, magnified from a specimen measuring 10 mm. in diameter.
„ 2. Portion of test of same, facing the median ambulacral space.

Salenia hastigera, A. Ag. (figs. 3–17), p. 54.

Fig. 3. Abactinal view of specimen of *Salenia hastigera*, measuring 14 mm. in diameter.
,, 4. The same species seen in profile, denuded of spines, 13 mm. in diameter.
,, 5. The same seen from the actinal side, denuded.
,, 6. The same from the abactinal side.
,, 7. Magnified portion of the test of same facing the median ambulacral space.
,, 8. Magnified portion of the test of same facing the median interambulacral space.
,, 9. Magnified portion of actinal edge of test of same.
,, 10. Abactinal system of same.
,, 11. Still further magnified portion of the ambulacral plates, and of the adjoining primary interambulacral plate of same.
,, 12. Young specimen, measuring 9 mm. in diameter, seen from the abactinal side.
,, 13. The same as fig. 12, seen from the actinal side.
,, 14. Magnified portion of test of same as fig. 12, facing the median ambulacral space.
,, 15. Magnified portion of test of same, facing the median interambulacral space.
,, 16. Magnified portion of abactinal system, showing madreporic body of fig. 10.
,, 16 *a*. Magnified portion of abactinal system, showing the rudimentary spines covering the genital and ocular plates.
,, 17. Magnified portion of primary spine of *Salenia hastigera*.
,, 17 *a*, *b*. Jaws of *Salenia hastigera* with the teeth, as seen in profile and from the outside *b*.

PLATE V.

Cœlopleurus maillardi, Mich. (figs. 1–3), p. 60.

Fig. 1. Large specimen (n. s.) with radioles, coloured light brown at base, and with shoe of uniform tint to extremity.
,, 2. The same seen from the actinal side, to show the spathiform shoe of the radioles, characteristic of the Arbaciadæ.
,, 3. A smaller specimen, with the shoe of the radioles brilliantly banded with vermillion.

PLATE VI.

Cœlopleurus maillardi, Mich. (figs. 1–22), p. 60.

Fig. 1. Denuded test (n. s.) seen in profile.
,, 2. The same seen from the abactinal side.
,, 3. The same seen from the actinal side.

Fig. 4. Magnified view of the abactinal system.
,, 5. Magnified portion of test seen facing the median ambulacral line.
,, 6. Magnified portion of test seen facing the median interambulacral line.
,, 7. Portion of test adjoining actinostome of same.
,, 8. Smaller specimen (n. s.) seen from the actinal side (one with banded shoes, fig. 3, Pl. V.).
,, 9. Magnified portion of test facing median ambulacral line, from fig. 8.
,, 9 *a*. Magnified portion of test of fig. 8, facing median interambulacral line.
,, 10. Magnified portion of test of fig. 8, adjoining actinostome.
,, 11. Still smaller specimen (n. s.), seen from the actinal side.
,, 12. Magnified portion of test of fig. 11, seen facing the median ambulacral line.
,, 13. Magnified portion of test of fig. 11, seen facing the median interambulacral line.
,, 14. Magnified abactinal area of fig. 11.
,, 15. Jaws of large specimen magnified.
,, 16. Long, slender pedicellariæ among the primary radioles of test, magnified.
,, 17. Short, spherical pedicellariæ, mainly found in space adjoining the bare part of the abactinal region of the median interambulacral space, magnified.
,, 18. The opposite view of fig. 17.
,, 19 *a, b, c, d*. Different forms of straight, primary radioles, mainly from the actinal edge of the test, and below the equatorial line of test; all natural size except *d* ($\frac{2}{1}$).
,, 20 *a, b, c*. Different forms of radioles, from the actinal side ($\frac{3}{1}$).
,, 20 *d* and 21 *d* are small radioles, closely packed near abactinal region of test in both areas ($\frac{6}{1}$).
,, 21 *a, b, c*. Different radioles from the actinal region of test; all natural size except *b* ($\frac{2}{1}$).
,, 22 *a, b, c*. Primary curved radioles, mainly from the equatorial region of test; natural size.
a′ c′ are figures of *a* and *c* seen from above, to show the triangular shape of the shaft of the radioles.
,, 22 *d*. Radiole, with flattened shoe, found near actinal edge of the test ($\frac{2}{1}$), similar to that of the Arbaciadæ.

PLATE VI[a].

Echinus horridus, A. Ag. (figs. 1–5), p. 115.

Fig. 1. Abactinal system ($\frac{3}{1}$).
,, 2. Part of side of test to show the size of the spines; natural size.

Fig. 3. Coronal plates of abactinal surface near lower part of test ($\frac{2}{1}$).
„ 4. Coronal plates of actinal surface ($\frac{2}{1}$).
„ 5. Coronal plates of abactinal surface, somewhat above the plates of fig. 3 ($\frac{2}{1}$).

Micropyga tuberculata, A. Ag. (figs. 6, 7), p. 68.

„ 6. Abactinal system of young specimen, measuring 8 mm. ($\frac{12}{1}$).
„ 7. Actinal system of same ($\frac{12}{1}$).

Trigonocidaris monolini, A. Ag. (figs. 8–10), p. 111.

„ 8. Actinal system of specimen measuring 8 mm. in diameter ($\frac{12}{1}$).
„ 9. Abactinal system of same ($\frac{12}{1}$).
„ 10. Plates of the abactinal surface of the test immediately above the ambitus of same.

Prionechinus sagittiger, A. Ag. (figs. 11–14), p. 109.

„ 11. Specimen measuring 7 mm. in diameter, covered with spines, seen from the abactinal side.
„ 11 *a*. Magnified primary spine.
„ 12. Actinal system of same ($\frac{12}{1}$).
„ 13. Abactinal system of same.
„ 14. Coronal plates of test above ambitus of same.

Cottaldia forbesiana, A. Ag. (figs. 15–17), p. 112.

„ 15. Coronal plates of test above ambitus, same as fig. 16.
„ 16. Abactinal system of specimen measuring 17 mm. in diameter.
„ 17. Magnified primary spine.

PLATE VII.

Micropyga tuberculata, A. Ag. (figs. 1–9), p. 68.

Fig. 1. Seen from the abactinal pole; natural size.
„ 2. Same, seen from the actinal side.
„ 3. Magnified view of the actinal cuts.
„ 4. Magnified view of portion of interambulacral and ambulacral zones of the actinal side.
„ 5. Magnified view of portion of interambulacraland ambulacral zone of the abactinal side.
„ 6. Magnified view of denuded abactinal system.

Fig. 7. Interambulacral and ambulacral zones of a smaller specimen (natural size) from the abactinal side.
,, 8. Same, seen from the actinal side.
,, 9. Abactinal system of same specimen magnified.

PLATE VIII.

Aspidodiadema tonsum, A. Ag. (figs. 1-9), p. 66.

Fig. 1. Seen from the abactinal side ($\frac{2}{1}$).
,, 2. Same species seen in profile, slightly enlarged.
,, 3. Same as fig. 2, seen from the actinal side, slightly enlarged.
,, 4. Denuded specimen, measuring 16mm. in diameter, seen from the abactinal pole, to show the anal plates.
,, 5. Same, as fig. 4, seen in profile.
,, 6. Anal system of another specimen, showing anal plates covered with miliary spines.
,, 7. Enlarged actinostome of fig. 1.
,, 8. Enlarged view of fig. 5, facing the median interambulacral line.
,, 9. Enlarged view of same facing the median ambulacral line.

Aspidodiadema microtuberculatum, A. Ag. (figs. 10–16), p. 65.

,, 10. Profile of a specimen covered with spines; natural size.
,, 11. Enlarged view from actinal side, denuded (26 mm. in diameter).
,, 12. Same, seen from the abactinal pole.
,, 13. Enlarged view of genital ring.
,, 14. Enlarged view of actinostome.
,, 15. Enlarged view of actinostome actinal membrane denuded to show the size of the buccal plates.
,, 16. Enlarged view of primary interambulacral tubercles, with a portion of the included ambulacral area.

PLATE IX.

Phormosoma luculentum, A. Ag. (figs. 1–2), p. 97.

Fig. 1. Seen from above; natural size.
,, 2. Seen in profile.

PLATE X.

Phormosoma luculentum, A. Ag. (figs. 1–4 *a,b,c*), p. 97.

Fig. 1. Seen from the actinal side; natural size.

Fig. 2. Abactinal system of same, somewhat enlarged.
,, 3. Actinal system of same, somewhat enlarged.
,, 4 *a*. Tip of spine from the actinal side to show the shape of shoe, enlarged. 4 *b*. The same seen from the side of the shoe. 4 *c*. Another spine, with differently-shaped shoe, seen from the side.

PLATE X[a].

Pleurechinus bothryoides, Ag. (figs. 1, 2), p. 108.

Fig. 1. Abactinal system of specimen measuring 18 mm. in diameter.
,, 2. Enlarged view of part of sides of the test of same specimen.

Phormosoma luculentum, A. Ag. (figs. 3–7), p. 97.

,, 3. Denuded segment of test from the abactinal side.
,, 4. View of actinal segment of same specimen.
,, 5, 6. Sheathed spines, similar to those of *A. grubii*, from the abactinal part of the test close to the apical system.
,, 7. One of the large pedicellariæ of the actinal surface of the test.

Astropyga radiata, Gray (figs. 8, 9).

,, 8. Interior view of interambulacral plates of the actinal side, showing the deep pits of the base of the primary tubercles.
,, 9. Interior view of interambulacral plates of the actinal plates, showing the lapping of the edges and the two plates which make up each half of the interambulacral zone at that point.

PLATE X[b].

Phormosoma bursarium, A. Ag. (figs. 1–9), p. 99.

Fig. 1. Seen from the abactinal side; natural size.
,, 2. Same, seen from the actinal side.
,, 3. Denuded portion of actinal surface of the test and actinostome of same.
,, 4. Abactinal system and denuded portion of the abactinal surface of same.
,, 5. Ambulacral and interambulacral plates of abactinal surface of same about one-third from the edge of the test ($\frac{2}{1}$).
,, 6. Plates of actinal surface of test about one-third from the edge of the test ($\frac{2}{1}$).
,, 7. Plates from the very edge of the test, showing the accumulation of miliaries forming a rudimentary fasciole ($\frac{2}{1}$).
,, 8. Enlarged view of the abactinal system ($\frac{2}{1}$).

Fig. 9. One of the pedicellariæ which are common along the edge of the test along the line of the miliaries.

PLATE XI.

Phormosoma hoplacantha, Wy. Thom. (figs. 1–4), p. 101.

Fig. 1. Segment of test seen from the abactinal side; half natural size (312 mm. in diameter).
,, 2. Segment of same seen from the actinal side.
,, 3. Abactinal system covered with spines.
,, 4. Part of abactinal system denuded, to show the large anal plates separating the plates of the genital ring ($\frac{2}{1}$).

PLATE XII.

Phormosoma hoplacantha, Wy. Thom. (figs. 1–4), p. 101.

Fig. 1. Half of test seen in profile; same specimen as that figured on Plate XI. (half natural size).
,, 2. Segment of test seen with the actinal floor removed, to show the position of the ovaries and of the mesenteries separating the ovaries from the poriferous zone.
,, 3. Same, seen from the interior to show the mode of imbricating of the buccal plates; they lap away from the actinostome ($\frac{2}{1}$).
,, 4. Part of actinal system denuded to show the arrangement of the buccal plates ($\frac{2}{1}$).

PLATE XII^a.

Young Echinothuridæ (figs. 1–9), p. 71.

Fig. 1. *Phormosoma rigidum*, A. Ag., seen from abactinal side ($\frac{1 \cdot 5}{1}$).
,, 2. Abactinal system of same still further enlarged ($\frac{3}{1}$).
,, 3. Segment of actinal surface of test of same ($\frac{3}{1}$).
,, 4. Segment of abactinal surface of test of same ($\frac{3}{1}$).
,, 5. Abactinal system and segment of test of young *Asthenosoma gracile*, A. Ag. ($\frac{6}{1}$), 24 mm. in diameter.
,, 6. Segment of actinal surface of same.
,, 7. Abactinal system of *Phormosoma asterias*, measuring 30 mm. in diameter ($\frac{4}{1}$).
,, 8. Segment of actinal surface of same ($\frac{4}{1}$).
,, 9. Segment of abactinal surface of same ($\frac{4}{1}$).

Phormosoma hoplacantha, Wy. Thom. (figs. 10-13), p. 101

Fig. 10. Segment of actinal surface near ambitus; natural size.
,, 11. Same plates, seen from the interior of the test.
,, 12. Plates from the abactinal surface near ambitus seen from the interior, slightly enlarged.
,, 13. Same plates, seen from the abactinal surface.

Asthenosoma tessellatum, A. Ag. (figs. 14, 15), p. 88.

,, 14 Coronal plates of actinal surface near ambitus ($\frac{1.5}{}$).
,, 15. Coronal plates of abactinal surface near ambitus ($\frac{1.5}{1}$).

PLATE XIII.

Phormosoma tenue, A. Ag. (figs. 1, 2), p. 91.

Fig. 1. Seen from the abactinal side with spines.
,, 2. Same, seen in profile.
Both figures natural size.

PLATE XIV.

Phormosoma tenue, A. Ag. (figs. 1–4), p. 91.

Fig. 1. Interior of the abactinal part of the test to show the ovaries, the large ambulacral tubes, and the indistinct division into secondary plates of the large primary plates of both areas; natural size.
,, 2. Interior view of the actinal part of the test, showing the course of the alimentary canal, the mesenteric loops m, m' arching over the ambulacral system, and the large ambulacral tubes a with the tubes extending at right angles from it to the ambulacral vesicles a'.
,, 3. Magnified view of the abactinal system.
,, 4. Magnified view of the actinal system.

PLATE XV.

Asthenosoma grubii, A. Ag. (figs. 1, 2), p. 82

Fig. 1. Seen from the abactinal side; natural size.
,, 2. Same, seen in profile.

PLATE XVI.

Asthenosoma grubii, A. Ag. (figs. 1–13), p. 82.

Fig. 1. Seen from the actinal side; natural size.
,, 2. Short spine with membraneous sheath from the abactinal surface of fig. 1, Plate XV., enlarged.
,, 3, 4. Longer spines with membraneous sheaths.
,, 5. Short, sharp miliary spine.
,, 6 *a, b, c*. Different parts of spine (fig. 4) without membraneous sheath.
,, 7. Short spine with club-shaped membraneous sheath at tip.
,, 8. Another spine of same kind as fig. 7.
,, 9. Same spine, different view.
,, 10. Large short-stemmed pedicellaria of actinal surface.
,, 11. Small-headed, long-stemmed pedicellaria of the abactinal surface.
,, 12. Long-stemmed trifid pedicellaria of the actinal surface.
,, 13. Somewhat smaller pedicellaria of same kind as fig. 12, expanded.

PLATE XVII.

Asthenosoma grubii, A. Ag. (figs. 1–6), p. 82.

Fig. 1. Segment of test seen from the actinal side, denuded of spines; natural size.
,, 2. Denuded segment of the test, abactinal side, natural size.
,, 3. Magnified view of abactinal system.
,, 4. Magnified view of actinal system.
,, 5. Portion of the ambulacral system, abactinal side.
,, 6. Portion of the ambulacral system, actinal side. The tubercles on figs. 1 and 2 are for the greater part perforated.

PLATE XVII[a].

Asthenosoma gracile, A. Ag. (figs. 1–4), p. 89.

Fig. 1. Seen from the abactinal surface; natural size.
,, 2. Abactinal system denuded ($\frac{3}{1}$).
,, 3. Coronal plates of actinal surface near the ambitus ($\frac{3}{1}$).
,, 4. Coronal plates of the abactinal surface near the ambitus ($\frac{3}{1}$).

Asthenosoma coriaceum, A. Ag. (figs. 5–7), p. 88.

,, 5. Denuded abactinal system of specimen measuring 212 mm. in diameter; natural size.

Fig. 6. Ambulacral and interambulacral plates of abactinal surface of same specimen near ambitus ($\frac{1.5}{1}$).

„ 7. Ambulacral and interambulacral plates of actinal surface of same near ambitus ($\frac{1.5}{1}$).

Phormosoma tenue, A. Ag. (fig. 8), p. 91.

„ 8. Abactinal system of specimen measuring 127 mm. ($\frac{2}{1}$).

PLATE XVIII.

Asthenosoma pellucidum, A. Ag. (figs. 1–6), p. 85.

Fig. 1. Segment of test of specimen from the actinal side, measuring 37 mm. in diameter ($\frac{2}{1}$).

„ 2. Same, seen from the abactinal side.

„ 3. Abactinal system of same ($\frac{4}{1}$).

„ 4. Segment of test of specimen measuring 59 mm., seen from the actinal side ($\frac{2}{1}$).

„ 5. Same, seen from the abactinal side.

„ 6. Abactinal system of same ($\frac{4}{1}$).

Phormosoma tenue, A. Ag. (figs. 7–9), p. 91.

„ 7. Segment of test of specimen measuring 90 mm., seen from the abactinal side ($\frac{2}{1}$).

„ 8. Same, seen from the actinal side.

„ 9. Abactinal system of same ($\frac{4}{1}$).

PLATE XVIII[a].

Phormosoma tenue, A. Ag. (figs. 1–13), p. 91.

Fig. 1. Portion of test of specimen, measuring 145 mm., adjoining ambitus of abactinal surface ($\frac{1.5}{1}$).

„ 2. Denuded portion of test of abactinal surface of same, near abactinal system.

„ 3. Denuded portion of actinal surface of test of same, near ambitus.

„ 4. Interior view of preparation of abactinal surface, showing subdivisions of coronal plates; specimen measuring 131 mm. ($\frac{2}{1}$).

„ 5. Interior view of actinal surface, not cleaned ($\frac{2}{1}$).

„ 6. Main ambulacral tube, with lateral branches leading to ampullæ, actinal surface ($\frac{2}{1}$).

„ 7. Interior view of abactinal part of test, median part ($\frac{2}{1}$).

„ 8. Interior view of abactinal part of test, preparation ($\frac{2}{1}$).

„ 9. Actinal part of test, median part ($\frac{2}{1}$).

Fig. 11–13. Greatly enlarged views of pedicellariæ.
,, 11. Pedicellaria of the abactinal part of test.
,, 12. One of the pedicellariæ of actinal surface.
,, 13. One of the trifid abactinal pedicellariæ.

Asthenosoma pellucidum, A. Ag. (figs. 3*a*, 14–17), p. 85.

,, 13 *a*. Denuded portion of abactinal surface of test, median part ($\frac{3}{1}$).
,, 14. Portion of abactinal part of test of specimen, measuring 37 mm.
,, 15. Portion of the actinal side of test of same ($\frac{4}{1}$).
,, 16. Portion of the abactinal side of test of larger specimen, measuring 59 mm. ($\frac{4}{1}$).
,, 17. Portion of the actinal side of test of same specimen as fig. 16 ($\frac{4}{1}$).

PLATE XVIII[b].

Phormosoma tenue, A. Ag. (figs. 1–13), p. 91.

Fig. 1. Interior view of abactinal system of specimen, measuring 133 mm. in diameter ($\frac{4}{1}$).
,, 2. Same, seen from the exterior.
,, 3. Segment of actinal membrane seen externally ($\frac{2}{1}$).
,, 4. Actinal system seen from the interior, showing the extension of the main ambulacral tubes and the position of the auricles, jaws removed ($\frac{2}{1}$).
,, 5. Same, with the jaws in place.
,, 6. Slightly inclined view, showing the low and feeble auricles.
,, 7. Jaws, seen in profile ($\frac{2}{1}$).
,, 8. Single jaw, seen from inside.
,, 8 *a*. Same, in profile.
,, 9, 9*a*, 9*b*. Different pieces of the support of the jaws.
,, 10. Part of main ambulacral tube with lateral branches, abactinal side ($\frac{4}{1}$).
,, 11. Same near the ambitus ($\frac{4}{1}$).
,, 12. Portion of abactinal surface of test, adjoining the abactinal system ($\frac{4}{1}$).
,, 13. Portion of actinal surface of test, adjoining the ambitus ($\frac{4}{1}$).

PLATE XVIII[c].

Phormosoma luculentum, A. Ag. (figs. 1–4), p. 97.

Fig. 1. Young specimen, measuring 18 mm. in diameter, seen from the actinal side.
,, 2. The same, seen from the abactinal side.
,, 3. Abactinal system and segment of abactinal surface of somewhat older specimen, measuring 36 mm. in diameter.
,, 4. Segment of actinal surface of same specimen.

Phormosoma tenue, A. Ag. (figs. 5–9), p. 91.

Fig. 5. Abactinal system and segment of abactinal surface of young specimen, measuring 18 mm. in diameter ($\frac{4}{1}$).

,, 6. Abactinal system and segment of abactinal surface of young specimen, measuring 49 mm. in diameter.

,, 7. Actinal system and segment of actinal surface of same specimen as fig. 6.

,, 8. Coronal plates, near ambitus, of specimen measuring 90 mm. in diameter, from the abactinal surface.

,, 9. Coronal plates of actinal surface near ambitus of same specimen as fig. 8.

Micropyga tuberculata, A. Ag. (figs. 10, 11), p. 68.

,, 10. Young specimen, measuring 7 mm. in diameter, seen from the abactinal surface.

,, 11. Same, seen from the actinal side.

Phormosoma uranus, Wy. Thom., p. 103.

,, 12. Actinal system and segment of actinal surface of young specimen, measuring 8 mm. in diameter ($\frac{6}{1}$).

PLATE XIX.

Asthenosoma pellucidum, A. Ag. (figs. 1–6), p. 85.

Fig. 1. Young specimen, seen from the actinal side; natural size.

,, 2. Same specimen, seen from the abactinal side.

,, 3. Same, seen in profile.

,, 4. Somewhat larger specimen, seen from the actinal side.

,, 5. Same specimen, seen from the abactinal side.

,, 6. Same, seen in profile.

Phormosoma tenue, A. Ag. (figs. 7–9), p. 91.

,, 7. Young specimen, seen from the abactinal side.

,, 8. Same, seen from the actinal side.

,, 9. Same, seen in profile.

By mistake of the draughtsman the profile figures are all represented with the actinal surface uppermost.

All figures natural size.

PLATE XIX[a].

Asthenosoma tessellatum, A. Ag. (fig. 1), p. 88.

Fig. 1. Seen from the actinal side ; natural size.

Phormosoma tenue, A. Ag. (fig. 1), p. 91.

„ 2. Seen from the actinal side ; natural size.

PLATE XIX[b].

Asthenosoma tessellatum, A. Ag. (figs. 1–4), p. 91.

Fig. 1. Seen in profile.
„ 2. Same, seen from the abactinal side ; natural size.
„ 3. Abactinal system of same, denuded ($\frac{2}{1}$).
„ 4. Magnified portion of ambulacral area, to show the pointed tentacles of the abactinal system ($\frac{2}{1}$).

PLATE XX.

Hemiaster zonatus, A. Ag. (figs. 1–4), p. 186.

Fig. 1. *Hemiaster zonatus*, seen from the abactinal side ; natural size.
„ 2. Same, seen from the actinal side.
„ 3. Same, seen from the anal extremity.
„ 4. Same, seen in profile.

Hemiaster gibbosus, A. Ag. (figs. 5–16, 22), p. 184.

„ 5. *Hemiaster gibbosus*, denuded, seen from the abactinal side ($\frac{2}{1}$).
„ 6. Same, seen from the actinal side.
„ 7. Same, seen in profile.
„ 8. Sam e,seen from the anal extremity.
„ 9. Magnified view of half the petaloid ambulacra.
„ 10. Magnified view of portion of the side of the test adjoining lateral ambulacra.
„ 11. Magnified view of abactinal system.
„ 12. Group of spines and pedicellariæ, from the actinal side.
„ 13. Granular tuberculation of miliaries.
„ 14, 15. Club-shaped spines near actinostome.
„ 16. Ambulacral sucker near the actinostome.
„ 22. Suckers from the lateral petaloid ambulacra.

Catopygus recens, A. Ag. (figs. 17–21), p. 123.

Fig. 17. Petaloid ambulacra of *Catopygus recens* ($\frac{2\cdot5}{1}$).
,, 18. *Catopygus recens*, seen from the abactinal side; natural size.
,, 19. Same, seen from the actinal side.
,, 20. Same, seen from the anal extremity.
,, 21. Same, seen in profile.

PLATE XX[a].

Hemiaster cavernosus, A. Ag. (figs. 1–22), p. 177.

Fig. 1. Female, seen from the abactinal side, showing the mode of carrying the young in the deeply-sunken petaloid ambulacral areas.
,, 2. Single petal, with the young less advanced than in fig. 1 ($\frac{4}{1}$).
,, 3. Test, seen from the actinal side (large male).
,, 4. Large male, seen from the abactinal side, to show the petaloid ambulacra slightly sunken below the general level of the test.
Figs. 1, 3, 4, all somewhat enlarged ($\frac{1\cdot5}{1}$).
,, 5. Interior view of abactinal part of test, showing the narrow, slightly swollen petaloid ambulacra of a male; natural size.
,, 6. Same view of a female, showing the broad, swollen petaloid ambulacra; natural size.
,, 7. Young *Hemiaster*, taken from the pouch of the petaloid ambulacra, still somewhat circular with straight primary spines, seen from the abactinal pole; natural size, 2 mm.
,, 8. Somewhat older *Hemiaster*, with curved primary spines, seen from the abactinal pole; natural size, 3 mm.
,, 8 *a*. Three spines of fig. 8; magnified.
,, 9. Young *Hemiaster*. about in condition of fig. 8, denuded of spines, showing the simple ambulacral pores, the large anal opening within the peripetalous fasciole, and the ring of large primary tubercles, forming its inner edge; magnified.
,, 10. The same, somewhat less magnified, seen from the actinal side.
,, 11. Section through a young *Hemiaster* of about this stage, showing the course of the alimentary canal.
,, 12. Magnified view of portion of the test of fig. 9, showing a part of the ambulacral and interambulacral systems and a piece of the peripetalous fasciole.
,, 13. Young *Hemiaster*, measuring 5·5 mm.; the anal system is just beyond the edge of the broad peripetalous fasciole, seen from the abactinal side.

Fig. 14. Somewhat older stage than fig. 3, seen from the same side of the test, measuring 8 mm.
,, 15. Still older stage, measuring 9 mm. First appearance of the genital plates.
,, 16. Somewhat more advanced than fig. 15, measuring 11 mm.
,, 17. Older than fig. 16, measuring 12 mm.
,, 18. Older than fig. 17, measuring 15 mm.
,, 19. Female (abactinal side) with deeply-sunken, broad petaloid ambulacra, and two genital pores; natural size.
,, 20. Female with narrower, deeply-sunken petaloid ambulacra, and three genital pores; natural size.
Figs. 19 and 20 are not fully grown.
,, 21. Abactinal system of large male; magnified.
,, 22. Abactinal system of large female; magnified.
The largest specimen measuring 50 mm. in longitudinal diameter.

PLATE XXI.

Breynia australasiæ, Gray (figs. 1, 2), p. 177.

Fig. 1. Seen from the actinal side; natural size.
,, 2. Seen from the abactinal side; natural size.

Palæotropus lovéni, A. Ag. (figs. 3–16), p. 158.

,, 3. Enlarged view of denuded specimen, seen from the abactinal side ($\frac{2}{1}$).
,, 4. Same, seen from the actinal side.
,, 5. Same, seen in profile.
,, 6. Same, seen facing the anterior extremity.
,, 7. Same, seen facing the anal system.
,, 8. Enlarged view of anal system and of subanal fasciole.
,, 8 *a*. Plates of actinostome.
,, 9. Profile view of *Palæotropus loveni*; natural size, with its spines.
,, 10. Same, seen from the actinal side.
,, 11. Same, seen from the abactinal side.
,, 12. Abactinal system, seen from the interior of the test.
,, 13. Abactinal system, denuded.
,, 14. Actinostome, seen from the interior of the test.
,, 15. Denuded actinostome.
,, 16. Enlarged view of primary and secondary tubercles from the actinal surface.

PLATE XXII.

Pourtalesia phiale, Wy. Thom. (figs. 1–5), p. 138.

Fig. 1. Seen from the actinal side ($\frac{2}{1}$).
„ 2. Profile view of same.
„ 3. Seen from the abactinal side.
„ 4. Seen facing the actinal extremity.
„ 5. Seen facing the anal extremity.

Pourtalesia hispida, A. Ag. (figs. 6–19), p. 136.

„ 6. Profile view of *Pourtalesia hispida* ($\frac{1\cdot5}{1}$).
„ 7. Same, seen from the abactinal side.
„ 8. Same, seen from the actinal side.
„ 9. Enlarged profile view of anal extremity.
„ 10. Interior profile view of test, to show course of the anterior part of the alimentary canal and the genital organs.
„ 11. Interior profile view, showing the position of the posterior portion of the alimentary canal; natural size.
„ 12. End view facing the anal extremity ($\frac{1\cdot5}{1}$).
„ 13. End view of same, facing the actinal extremity.
„ 14. Interior view of anal extremity, seen from above.
„ 15. Interior view of actinal groove, seen in profile.
„ 16. Exterior view of actinal groove, seen from below.
„ 17. Interior view of actinal groove, seen from below.
„ 18. Interior view of abactinal system, showing position of ovaries.
„ 19. Interior view of abactinal system, showing the bivium and trivium.

PLATE XXII

Pourtalesia phiale, Wy. Thom. (figs. 1, 2), p. 138.

„ 1. Seen in profile (denuded), enlarged ($\frac{4}{1}$).
„ 2. Seen from the actinal side (denuded), enlarged.

Pourtalesia rosea, A. Ag. (figs. 3–6), p. 139.

„ 3. Anal snout, seen in profile ($\frac{2}{1}$), actinal surface uppermost.
„ 4. Anal snout, seen from the actinal side.
„ 5. Same, seen from the abactinal side.
„ 6. Interior view of abactinal system.

Pourtalesia laguncula, A. Ag. (figs. 7–15), p. 137.

Fig. 7. Seen in profile, denuded ($\frac{4}{1}$).
„ 8. Same, seen from the actinal end.
„ 9. Same, seen from the actinal side.
„ 10. Interior view of the abactinal system.
„ 11. Three interambulacral plates from the median part of the test.
„ 12. Interior view of anterior part of test, to show Hoffman's organ.
„ 13. Interior view of anal extremity of test.
„ 14. One of cluster of genital organs.

PLATE XXIII.

Cionobrissus revinctus, A. Ag. (figs.1–12), p. 188.

Fig. 1. Seen in profile denuded; natural size.
„ 2. Seen from the abactinal side, covered with spines.
„ 3. Same, seen from the actinal side.
„ 4. Same as fig. 1, seen facing the anal extremity.
„ 5. Same as fig. 1, seen facing the anterior extremity.
„ 6. Petals and surrounding peripetalous fasciole.
„ 7. Magnified view of posterior extremity, seen in profile.
„ 8. Interior view of actinostome.
„ 9. Exterior view of actinostome denuded.
„ 10. Profile view of course of alimentary canal.
„ 11. Actinal view of same.
„ 12. Abactinal view of same.

PLATE XXIV.

Homolampas fulva, A. Ag. (figs. 1–12), p. 164.

Fig. 1. Seen in profile, denuded; natural size.
„ 2. Same, seen from the abactinal side, one-half of test covered with spines.
„ 3. Same, seen from the actinal side.
„ 4. Enlarged view of posterior extremity, showing anal system and subanal fasciole.
„ 5. Interior of anal part of test, showing termination of alimentary canal.
„ 6. Interior view of apical system, showing the four ovaries.
„ 7. Interior view of apical system, showing the four genital openings.

Fig. 8. Interior view of apical portion of test, showing the purse-like pouches under the large Lovenia-like primary spines.
„ 9. Magnified portion of the actinal surface of the posterior interambulacral area.
„ 10. Interior view of pouched rings corresponding to the primary tubercles of the actinal surface.
„ 11. Magnified view of actinostome.
„ 12. Magnified view of the apical system.

PLATE XXV.

Linopneustes (*Paleopneustes*) *murrayi*, A. Ag. (figs. 1–9), p. 168.

Fig. 1. Test partly denuded, partly covered with spines, seen from the abactinal side; natural size.
„ 2. Same, seen from the actinal side.
„ 3. Same, seen in profile.
„ 4. Same, seen facing the anal system.
„ 5. Abactinal system, magnified.
„ 6. Magnified view of anal system, and of subanal fasciole.
„ 7. Magnified view of actinostome and of surrounding plates.
„ 8. Interior view of apical system, and of tubes leading to genital organs and to limestone canal.
„ 9. Magnified view of part of one of the ambulacral tubes and plates adjoining the actinostome.

PLATE XXVI.

Spatagocystis challengeri, A. Ag. (figs. 1–11), p. 141.

Fig. 1. Seen in profile.
„ 2. Same, seen from the actinal surface.
„ 3. Same, seen from the abactinal side.
„ 4. Same, seen facing the anterior extremity.
„ 5. Same, seen facing the anal extremity.
„ 6. Profile view, showing course of alimentary canal.
„ 7. Profile view of smaller specimen.
„ 8. Same, seen from the actinal side.
„ 9. Same, seen from the abactinal side.
„ 10. Same, seen facing the anal extremity.

Fig. 11. Same, seen facing the anterior extremity.
All figures natural size.

PLATE XXVI[a].

Spatagocystis challengeri, A. Ag. (figs. 1–17), p. 141.

Fig. 1. Interior view, showing course of alimentary canal, seen from the actinal side.
,, 2. Portion of test showing the arrangement of the plates surrounding the right anterior part of the actinal surface, magnified.
,, 3. Magnified view of actinal groove, covered with spines.
,, 4. Actinal view of part of the test, showing the arrangement of the plates along the median part of the actinal surface, and posterior part of the actinal groove.
,, 5. Interior view of the pouch forming the anal system.
,, 6. Interior profile view of pouch, and termination of intestine in the posterior end of the pouch.
,, 7. Abactinal view of anal snout; test projecting over this removed.
,, 8. Magnified view of abactinal system and surrounding plates.
,, 9. Interior view of apical part of lateral anterior and posterior ambulacra, and the enclosed lateral interambulacrum and adjoining ambulacrum.
,, 10. Interior view of part of the abactinal median ridge (the pores should be in the outer plates); the median rows of plates are the interambulacral plates. See fig. 17.
,, 11. Interior view of the posterior part of the actinal surface, showing the course of the lateral posterior ambulacra, and arrangement of the plates forming the base of the anal snout.
,, 12. Same, seen from the actinal side, showing the large tuberculation forming the keel of the actinal plastron.
,, 13. Profile view of anal snout.
,, 14. Exterior view of part of test of anterior lateral ambulacra and adjoining interambulacra, showing the uniformity of the tuberculation.
,, 15, 16. Two views of the posterior extremity of test, seen in profile, one shaded to show the tuberculation, the other to show the arrangement of the plates and course of the ambulacral pores.
,, 17. Posterior extremity of the test, seen from the abactinal side, showing the arrangement of the plates and course of the lateral posterior ambulacral tubes.

Fig. 1, natural size; all others somewhat magnified.

PLATE XXVII.

Echinocrepis cuneata, A. Ag. (figs. 1–11), p. 145.

Fig. 1. Seen from the abactinal side, covered with spines.
,, 2. Same, seen from the actinal side.
,, 3. Same, seen in profile.
,, 4. Same, seen facing the anal extremity.
,, 5. Same, seen facing the anterior extremity.
,, 6. Interior view, seen from the actinal side, showing the course of the alimentary canal.
,, 7. End view of anterior part of test, denuded.
,, 8. Tuberculation of interambulacral plates of the median abactinal side of test.
,, 9. Magnified view of apical system and surrounding plates.
,, 10. Anal system, seen from the actinal side.
,, 11. Hoffman's organ in *Echinocrepis.*
Figs 1–6, natural size; all others somewhat enlarged.

PLATE XXVIII.

Pourtalesia ceratopyga, A. Ag. (figs.1–12), p. 134.

Fig. 1. Seen from the abactinal side, covered with spines; natural size.
,, 2. Same, seen in profile.
,, 3. Same, seen facing the anterior extremity.
,, 4. Same, seen facing the anal extremity.
,, 5. Interior view, showing general course of the alimentary canal.
,, 6. Actinal view of anterior part of test, denuded.
,, 7. Actinal view of posterior extremity of test.
,, 8. Actinal view of a smaller specimen (same as fig. 6).
,, 9. Abactinal view of anterior part of test of fig. 8.
,, 10. Interambulacral plates of test to show the regular tuberculation.
,, 11. Interior view of abactinal part of test.
,, 12. Abactinal system denuded.

PLATE XXVIII[a].

Pourtalesia carinata, A. Ag. (figs. 1–15), p. 133.

Fig. 1. Seen from the abactinal side; natural size.

Fig. 2. Same, seen in profile.
,, 3. Magnified portion of the posterior extremity, denuded, seen in profile.
,, 4. Anal snout, seen from the actinal side, denuded.
,, 5. Anal snout, seen from the abactinal side, covered with spines.
,, 6. Anal extremity, showing snout, and the connection of intestine with anal system.
,, 7. End view of the anal snout.
,, 8. Actinal groove and portion of actinal surface surrounding it, covered with spines.
,, 9. Interior view of actinostome, with adjoining plates, forming the actinal groove.
,, 10. Actinal edge of actinal groove, showing the plates adjoining it.
,, 11. Profile of actinal groove, seen from the interior.
,, 12. Abactinal system denuded.
,, 13. Interior view of abactinal part of test, with genital organs.
,, 14. Interior view of apical part of lateral anterior ambulacra.
,, 15. Large primary spines of the rounded keel, forming edges of anterior part of test.

PLATE XXIX.

Urechinus naresianus, A. Ag. (figs. 1–4), p. 146.

Fig. 1. Seen from the abactinal side of the test.
,, 2. Same, seen in profile.
,, 3. Same, seen from the actinal side.
,, 4. Same, seen facing the anal extremity.

Cystechinus wyvillii, A. Ag. (figs. 5–8), p. 152.

,, 5. Seen in profile.
,, 6. Same, seen facing the odd anterior ambulacrum.
,, 7. Same, seen from the abactinal side.
,, 8. Same, seen from the actinal side.
All figures natural size.

PLATE XXIX[a].

Cystechinus wyvillii, A. Ag. (figs. 1–20), p. 152.

Fig. 1. Young specimen, measuring 16 mm., seen from the abactinal side.
,, 2. Same, seen from the anal extremity.
,, 3. Same, seen from the actinal side.
,, 4. Same, seen in profile.

Fig. 5. Somewhat older than figs. 1–4, measuring 22 mm., seen from the abactinal side.
,, 6. Same, seen from the actinal side.
,, 7. Same, seen in profile.
,, 8. Same, seen facing the anal extremity.
,, 9. Still older specimen, measuring 39 mm., seen from the abactinal side.
,, 10. Same, seen from the actinal side.
,, 11. Same, seen facing the anal extremity.
,, 12. Same, seen in profile.
,, 11′. Abactinal system and surrounding plates of specimen, measuring 16 mm.
,, 12′. Abactinal system and surrounding plates of specimen, measuring 39 mm.
,, 13. Interior view of apical system and genital organs of imperfect specimen, measuring about 50 mm.
,, 14. Exterior view of apical system and surrounding plates (same as fig. 13).
,, 15. Interior view of actinal system of imperfect specimen, measuring about 35 mm.
,, 16. Exterior of same as fig. 16.
,, 17. Interior view of actinal system of specimen, measuring about 25 mm.
,, 18. Exterior view of same as fig. 17.
,, 19. Interior view of anal system and termination of intestine of specimen measuring about 35 mm.
,, 20. Exterior view of anal system of same as fig. 19.

PLATE XXIX[b].

Cystechinus wyvillii, A. Ag. (figs. 1–9), p. 152.

Fig. 1. Abactinal view of test, denuded; natural size.
,, 2. Same, seen from the actinal side.
,, 3. Same, seen in profile.
,, 4. Same, seen facing the anal extremity.
,, 5. Magnified view of plates surrounding the actinostome.
,, 6. Interior view of same as fig. 5.
,, 7. Interior view of the apical part of one of the lateral anterior ambulacra and adjoining interambulacral plates.
,, 8. Interior view from the actinal side, to show the course of the alimentary canal.
,, 9. Magnified view of one of the interambulacral plates, to show the ridges and tuberculation.

PLATE XXX.

Urechinus naresianus, A. Ag. (figs. 1–24), p. 146.

Fig. 1. Young specimen, measuring 27 mm., seen from the abactinal side.
,, 2. Same, seen in profile.
,, 3. Same, seen from the actinal side.
,, 4. Somewhat younger specimen, measuring 18 mm., seen from the abactinal side.
,, 5. Same, seen in profile.
,, 6. Same, seen facing the anal extremity.
,, 7. Another specimen, measuring 16 mm., differing somewhat in outline, seen from the abactinal side.
,, 8. Younger specimen than fig. 4, measuring 15 mm., seen from the abactinal side.
,, 9. Same, seen in profile.
,, 10. Same, seen from the actinal side.
,, 11. Still younger specimen, measuring only 13 mm., seen from the abactinal side.
,, 12. Same, seen from the actinal side.
,, 13. Same, seen in profile.
,, 14. Exterior view of actinostome and surrounding plates of specimen measuring 46 mm.
,, 15. Interior view of same.
,, 16. Abactinal system and surrounding plates of specimen measuring 46 mm.
,, 17. Interior view of apical system and surrounding plates of specimen measuring 46 mm.
,, 18. Interior view of anal system and portion of adjoining ambulacral areas.
,, 19. Anal system and indistinct subanal fasciole.
,, 20. Magnified primary spine, from the edge of ambitus of specimen measuring 40 mm.
,, 21. Miliary spine of same.
,, 22. Trifid elongate pedicellaria, with slender-stemmed articulation.
,, 23. Club-shaped pedicellaria, with heavy-stemmed articulation, seen in profile.
,, 24. Head of same, seen from above.

PLATE XXX[a].

Urechinus naresianus, A. Ag. (figs. 1–14), p. 146.

Fig. 1. Conical individual, seen from the abactinal side ($\frac{2}{1}$).
,, 2. Same, seen from the actinal side.
,, 3. Same, seen in profile.

Fig. 4. Same, seen facing the odd anterior ambulacrum.
,, 5. Same, seen facing the anal system.
,, 6. Actinostome of same, enlarged.
,, 7. Normal *Urechinus naresianus* seen in profile ($\frac{1\cdot5}{1}$).
,, 8. Same, seen from the abactinal side.
,, 8 *a*. Enlarged figure of abactinal system of same.
,, 9. Same, seen from the actinal side.
,, 10. Another specimen, with a subanal fasciole, measuring 48 mm., seen from the actinal side.
,, 10 *a*. Anal system of same, with a subanal fasciole, enlarged.
,, 11. Same, seen from the abactinal side.
,, 12. Same, seen in profile, showing the blunt anal snout.
,, 13. Same, seen facing the posterior extremity.
,, 14. Same, seen facing the odd anterior ambulacrum.

Brissus damesi, A. Ag. (figs. 15, 16), p. 197.

,, 15. Part of test of specimen, measuring 22 mm., seen from the abactinal side.
,, 16. Anal system of same, showing rudimentary fasciole, enlarged.

PLATE XXXI.

Pourtalesia laguncula, A. Ag. (figs. 1–11), p. 137.

Fig. 1. Seén from the actinal side, specimen measuring 22 mm.
,, 2. Same, seen from the abactinal side.
,, 3. Same, seen in profile.
,, 4. Profile view of anal snout, greatly enlarged.
,, 5. Same as fig. 3, seen facing the anal extremity.
,, 6. Same, seen facing the anterior extremity.
,, 7. Younger specimen, measuring 12 mm., seen from the actinal side.
,, 8. Same, seen from the abactinal side.
,, 9. Same, seen in profile.
,, 10. Elongated anal snout of different specimen, of about same size as fig. 7, seen in profile.
,, 11. Anal snout of another specimen, less elongate, measuring about 12 mm.

Genicopatagus affinis, A. Ag. (figs. 12–22), p. 162.

,, 12. Seen from the actinal side, natural size.
,, 13. Same, seen from the abactinal side.

Fig. 14. Same, seen in profile.
„ 15. Same, seen facing the anal extremity.
„ 16. Somewhat younger specimen, more circular in outline, seen from the abactinal side; natural size.
„ 17. Same, seen from the actinal side of the test.
„ 18. Same, seen from the end facing the anal system.
„ 19. Same, seen in profile.
„ 20. Still younger specimen, measuring 10 mm., quite angular in outline, seen from the abactinal side.
„ 21. Same, seen in profile.
„ 22. Same, seen from the actinal side.

PLATE XXXII.

Argopatagus vitreus, A. Ag. (figs. 1–6), p. 160.

Fig. 1. Seen from above; natural size.
„ 2. Same, seen from the actinal side.
„ 3. Same, seen in profile.
„ 4. End view of subanal fasciole, enlarged, abactinal side below.
„ 5. Actinostome, with surrounding plates, enlarged.
„ 6. Abactinal region of same enlarged.

Aceste bellidifera, Wy. Thom. (figs. 7–11), p. 195.

„ 7. Seen from the actinal side, enlarged (27 mm., n. s.).
„ 8. Same, seen from the abactinal side, still more enlarged.
„ 9. Same, seen facing the anterior extremity.
„ 10. Same, seen facing the anal extremity.
„ 11. Same, seen in profile.
Figs. 9, 10, 11 are drawn with the actinal side uppermost.

PLATE XXXIII.

Aërope rostrata, Wy. Thom. (figs. 1–13), p. 192.

Fig. 1. Seen from the abactinal side, measuring 43 mm.
„ 2. Same, seen from the actinal side.
„ 3. Same, seen in profile.
„ 4. Interior profile view, showing the course of the alimentary canal.

Fig. 5. Same seen facing the anal extremity.
„ 5′. Same as fig. 8, seen facing the anterior extremity.
„ 6. Enlarged view of large suckers of odd anterior ambulacrum of fig. 8.
„ 7. Anal system of fig. 8.
„ 8. Smaller specimen than fig. 1, measuring 20 mm., seen from the abactinal side.
„ 9. Same, seen from the actinal side.
„ 10. Same, seen in profile.
„ 11. Seen, facing the anal system, smaller than fig. 8.
„ 12. Same, seen facing the actinal extremity.
„ 13. Actinostome of fig. 9 ; magnified.

PLATE XXXIII[a].

Aceste bellidifera, Wy. Thom. (figs. 1–7), p. 195.

Fig. 1. Seen from the abactinal side ($\frac{3}{1}$).
„ 2. Same, seen from the actinal side.
„ 3. Same, seen in profile.
„ 4. Same, seen from the posterior extremity.
„ 5. Same, seen from the anterior extremity.
„ 6. Enlarged view of actinostome of fig. 5.
„ 7. Enlarged view of apical system and adjoining ambulacral area.

Aërope rostrata, Wy. Thom. (figs. 8–12), p. 192.

„ 8. Seen from the actinal side ($\frac{4}{1}$).
„ 9. Same, seen in profile.
„ 10. Enlarged view of apical system and of abactinal part of test.
„ 11. Enlarged view of actinostome.
„ 12. Enlarged view of anal system.

PLATE XXXIV.

Calymne relicta, Wy. Thom. (figs. 1–13), p. 155.

Specimen measuring 30 mm., copied in part from Thomson.

Fig. 1. Test, seen from the actinal side.
„ 2. Test, seen from the abactinal side
„ 3. Test, seen in profile.
„ 3 *a*. Cluster of paddle-shaped primary spines on the abactinal side of the edge of the posterior part of test.

Fig. 4. Enlarged end view of test, showing course of lateral fasciole across the posterior extremity.
,, 5. Interior view of abactinal surface of test; enlarged.
,, 6. Interior view of actinal floor of test; enlarged.
,, 7. Interior view of actinostome; enlarged.
,, 8. Actinostome, seen from the actinal side; enlarged.
,, 9. Large primary tubercles of abactinal surface, adjoining apical system, in odd anterior ambulacrum.
,, 8 (should be 10). Abactinal part of test, extending from upper part of the odd anterior ambulacrum to the cluster of primary spines in the median interambulacral space above the anal system between it and the apical system; enlarged.
,, 11. Cluster of primary spines, placed above the anal system on the abactinal extremity of the posterior part of the test. See fig. 3.
,, 11 *a*, *b*, *c*, *d*, *e*, *f*. Differently shaped primary spines.
,, 12. Anal system, protected by paddle-shaped primary spines round the abactinal edge.
,, 13. Shows the outline of the anal system, with the shape of the plates covering it.

Podocidaris prionigera, A. Ag. (figs. 14, 15), p. 59.

,, 14. Part of ambulacral and interambulacral regions of test, seen from the abactinal side, to show the relation of the primary and secondary tubercles adjoining the ambitus; enlarged.
,, 15. Enlarged view of abactinal system.

PLATE XXXV.

Cystechinus vesica, A. Ag. (figs. 1–20), p. 150.

Fig. 1. Seen from the abactinal pole; natural size.
,, 2. Same, seen in profile.
,, 3. Same, seen from the actinal side.
,, 4. Different specimen, showing shape assumed owing to extreme tenuity of test.
,, 5. Interior view, seen from actinal side, to show the course of the alimentary canal.
,, 6. Interior view of apical system and of genital organs.
,, 7. View of genital organs of a different individual.
,, 8. Actinostome, somewhat enlarged, covered with spines.
,, 9. Anal system, exterior view.

Fig. 10. Interior view of anal system, with termination of intestine.
„ 11. Interior view of actinostome and plates surrounding it.
„ 12. Exterior view of actinal system and surrounding plates.
„ 13. Interior view of actinal system, with the actinal termination of the ambulacral tubes and vesicles.
„ 14. Primary spine from the abactinal surface.
„ 15. Club-shaped spine from the edge of the test.
„ 16. Large triangular-headed pedicellaria from the actinal surface.
„ 17. Large club-shaped pedicellaria.
„ 18. Same, seen facing the line of division of the jaws.
„ 19. Young club-shaped pedicellaria.
„ 20. Gill-like ambulacral suckers, near the actinostome.

PLATE XXXV[a].

Genicopatagus affinis, A. Ag. (figs. 1–4), p. 162.

Fig. 1. Actinostome and surrounding plates of specimen measuring 37 mm. in diameter; greatly enlarged.
„ 2. Apical system and surrounding plates of same, with large tentacles issuing from double pores.
„ 3. Anal system of same, covered with spines.
„ 4. Ambulacral plates, and adjoining interambulacral plates from the median part of the test; magnified.

Cystechinus vesica, A. Ag. (figs. 5–8), p. 150.

„ 5. Abactinal system and adjoining plates.
„ 6. Same, seen from the interior, genital organs removed.
„ 7. Portion of ambulacrum and adjoining interambulacral plates, to show the tuberculation of the sides of the test.
„ 8. Interior view of lateral ambulacrum and adjoining interambulacral plates.

Echinocrepis cuneata, A. Ag. (figs 9–13), p. 145.

„ 9. Seen from the abactinal side; natural size.
„ 10. Same, seen from the actinal side.
„ 11. Same, seen in profile.
„ 12. Smaller specimen, seen facing the anterior extremity.
„ 13. Interior view, showing course of alimentary canal, seen from the actinal side.

PLATE XXXV[b].

Periaster limicola, A. Ag. (figs. 1–4), p, 204.

Fig. 1. Seen from the abactinal side, half test denuded.
„ 2. Same, seen from the actinal side.
„ 3. Same, seen in profile.
„ 4. Same, seen facing the posterior extremity.

Lovenia subcarinata, Gray (figs. 5–7), p. 175.

„ 5. Seen in profile.
„ 6. Same, seen from the abactinal side, partly denuded
„ 7. Same, seen from the actinal side.

Linopneustes (*Paleopneustes*) *murrayi*, A. Ag. (figs. 8–9*a*), p. 168.

„ 8. Young specimen, seen from the actinal side.
„ 9. Same, seen from the abactinal side.
„ 9 *a*. Same, seen facing the anal extremity.

Cystechinus clypeatus, A. Ag. (figs. 10, 11), p. 149.

„ 10. Apical system of large specimen.
„ 11. Anal system of same.

Rhinobrissus hemiasteroides, A. Ag. (figs. 12–15), p. 186.

„ 12. Seen from the abactinal side, half test denuded.
„ 13. Same, seen in profile.
„ 14. Same, seen from the actinal side.
„ 15. Same, seen facing the anal extremity.

Pourtalesia ceratopyga, A. Ag. (fig. 17), p. 134.

„ 17. Anterior extremity of test, to show arrangements of plates, from the abactinal side.

Cionobrissus revinctus, A. Ag. (fig. 18), p. 188.

„ 18. Anterior portion of test, seen from the actinal side ($\frac{2}{1}$).
All figures natural size except fig. 18.

PLATE XXXVI.

Schizaster ventricosus, Gray (figs. 1–3), p. 204.

Fig. 1. Seen from the abactinal pole; natural size.
,, 2. Same, seen from the actinal side.
,, 3. Same, seen in profile.

Mioropsis (*Schizaster*) *claudicans*, A. Ag. (figs. 4–7), p. 205.

,, 4. Seen from the abactinal side; natural size.
,, 5. Same, seen from the actinal side.
,, 6. Same, seen in profile.
,, 7. Enlarged view of petaloid ambulacra.

Schizaster japonicus, A. Ag. (figs. 8–13), p. 202.

,, 8. Seen from the abactinal side, covered with spines; natural size.
,, 9. Same, seen from the actinal side.
,, 10. Same, seen in profile.
,, 11. Denuded specimen, seen from the abactinal side.
,, 12. Same, seen in profile.
,, 13. Same, seen from the actinal side.

Schizaster moseleyi, A. Ag. (figs. 14–16), p. 203.

,, 14. Denuded test, seen from the abactinal side.
,, 15. Same, seen from the actinal side.
,, 16. Same, seen in profile.

PLATE XXXVII.

Maretia alta, A. Ag. (figs. 1–4), p. 172.

Fig 1. Seen from above, covered with spines.
,, 2. Same species, test denuded.
,, 3. Same, seen from the actinal side.
,, 4. Same, seen in profile.

Eupatagus valenciennesi, Agass. (figs. 5, 6), p. 173.

,, 5. Seen from the abactinal side.
,, 6. Same, seen from the actinal side.

Lovenia subcarinata, Gray (figs. 7–9), p. 175.

Fig. 7. Seen from the abactinal side.
" 8. Same, seen from the actinal side.
" 9. Same, seen from the anal extremity.

Echinolampas oviformis, Gray (figs. 10, 11), p. 123.

" 10. Seen from the abactinal surface.
" 11. Same, seen from the actinal side.
All the figures natural size.

PLATE XXXVIII.

Sections of Spines (figs. 1–31), p. 14.

Fig. 1. *Asthenosoma grubii.*
" 2. " "
" 3. *Pseudoboletia indiana.*
" 4. *Asthenosoma grubii.*
" 5. *Phormosoma tenue.*
" 6. *Asthenosoma pellucidum.*
" 7. *Cœlopleurus maillardi.*
" 8. " "
" 9. " "
" 10. *Salenia hastigera.*
" 11. *Goniocidaris florigera.*
" 12. *Porocidaris elegans.*
" 13. " "
" 14. " "
" 15. " "
" 16. " "
Fig. 17. *Aspidodiadema microtuberculatum.*
" 18. " "
" 19. *Aspidodiadema tonsum.*
" 20. *Encope michelini.*
" 21. *Mellita testudinata.*
" 22. *Clypeaster subdepressus.*
" 23. *Maretia planulata.*
" 24. *Linopneustes murrayi.*
" 25. *Argopatagus vitreus.*
" 26. *Homolampas fulva.*
" 27. *Rhynchopygus pacificus.*
" 28. *Linopneustes murrayi.*
" 29. " "
" 30. *Pourtalesia carinata.*
" 31. " "

Figs. 1^a, 2^a, 3^a, &c., are sectors of the same spine section still more magnified to show the structure somewhat more in detail.

PLATE XXXIX.

Sections of Spines (figs. 1–38), p. 14.

Fig. 1. *Micropyga tuberculata.*
,, 2. ,, ,,
,, 3. *Phormosoma hoplacantha.*
,, 4. ,, ,,
,, 5. ,, ,,
,, 6. ,, ,,
,, 7. ,, ,,
,, 8. *Phormosoma luculentum.*
,, 9. *Phormosoma tenue.*
,, 11. *Pseudoboletia indiana.*
,, 12. *Echinolampas oviformis.*
,, 13. *Lovenia elongata.*
,, 14. *Breynia australasiæ.*
,, 15. *Hemiaster cavernosus.*
,, 16. *Hemiaster gibbosus.*
,, 17. *Eupatagus valenciennesi.*
,, 18. *Argopatagus vitreus.*
,, 19. *Encope michelini.*
,, 20. *Genicopatagus affinis.*

Fig. 21. *Aceste bellidifera.*
,, 22. *Cionobrissus revinctus.*
,, 23. *Aërope rostrata.*
,, 24. *Calymne relicta.*
,, 25. ,, ,,
,, 26. ,, ,,
,, 27. *Cystechinus vesica.*
,, 28. *Cystechinus wyvillii.*
,, 29. *Urechinus naresianus.*
,, 30. ,, ,,
,, 31. *Echinocrepis cuneata.*
,, 32. ,, ,,
,, 33. *Palæotropus loveni.*
,, 34. *Pourtalesia hispida.*
,, 35. *Pourtalesia laguncula.*
,, 36. *Pourtalesia hispida.*
,, 37. *Spatagocystis challengeri.*
,, 38. *Periaster limicola.*

PLATE XL.

Figures and Details of Spines (figs. 1–68), p. 14.

Fig. 1–25. *Goniocidaris tubaria.*
,, 26–28. *Micropyga tuberculata.*
,, 29, 30. *Phormosoma tenue.*
,, 31–36. *Phormosoma luculentum.*
,, 37, 38. *Phormosoma hoplacantha.*
,, 39–42. *Asthenosoma pellucidum.*
,, 43, 44. *Prionechinus sagittiger.*
,, 45, 46. *Lovenia elongata.*

Fig. 47–50. *Breynia australasiæ.*
,, 51–53. *Moiropsis claudicans.*
,, 54, 55. *Maretia planulata.*
,, 56–58. *Urechinus naresianus.*
,, 59, 60. *Cystechinus wyvillii.*
,, 61, 62. *Pourtalesia laguncula.*
,, 63–65. *Calymne relicta.*
,, 66–68. *Aceste bellidefera.*

PLATE XLI.

Figures and Details of Spines (figs. 1–53), p. 14.

Fig. 1–6. *Periaster limicola.*
,, 7, 8. *Aërope rostrata.*
,, 9, 10. *Echinolampas oviformis.*
,, 11, 12. *Eupatagus valenciennesi.*
,, 13–16. *Aceste bellidifera.*
,, 17–20. *Maretia planulata.*
,, 21, 22. *Hemiaster cavernosus.*
,, 23–27. *Cystechinus wyvillii.*
,, 28, 29. *Palæotropus loveni.*
,, 30, 31. *Echinocrepis cuneata.*
Fig. 32–35. *Argopatagus vitreus.*
,, 36, 37. *Cystechinus vesica.*
,, 38, 39. *Genicopatagus affinis.*
,, 40. *Spatagocystis challengeri.*
,, 41–43. *Cionobrissus revinctus.*
,, 44–46. *Pourtalesia ceratopyga.*
,, 47, 48. *Pourtalesia hispida.*
,, 49–52. *Pourtalesia carinata.*
,, 53. *Pourtalesia laguncula.*

PLATE XLII.

Pedicellariæ (figs. 1–28).

Fig. 1. *Dorocidaris bracteata,* short, long-stemmed ambulacral pedicellaria.
,, 2. *Goniocidaris florigera,* slender-headed, long-stemmed pedicellaria.
,, 3. ,, ,, globular-headed, short-stemmed abactinal pedicellaria.
,, 4. *Aspidodiadema tonsum,* globular-headed, short-stemmed abactinal pedicellaria.
,, 5. ,, ,, long-headed, long-stemmed pedicellaria.
,, 6. ,, ,, magnified part of short interambulacral spines.
,, 7. *Phormosoma tenue,* one of the long-headed, long-stemmed pedicellariæ.
,, 8. *Asthenosoma grubii,* globular-headed, short-stemmed pedicellaria.
,, 9. ,, ,, long-headed, long-stemmed pedicellaria.
,, 10. *Spatagocystis challengeri,* large-headed pedicellaria (Pl. XLV. fig. 39).
,, 11. ,, ,, short-headed, toothed, cup-pronged pedicellaria (Pl. XLV. fig. 43).
,, 12. *Spatagocystis challengeri,* small-based, long-pronged pedicellaria (Pl. XLV. fig. 12).
,, 13. *Cystechinus wyvillii,* large-headed pedicellaria (Pl. XLV. fig. 28).
,, 14. ,, ,, extremity of rod supporting same.
,, 15. *Cystechinus clypeatus,* small large-headed pedicellaria (Pl. XLV. figs. 30, 31).
,, 16. ,, ,, end view of same.

Fig. 17. *Pourtalesia ceratopyga*, large-headed, coarsely-reticulated pedicellaria (Pl. XLV. figs. 57, 58).
„ 18. *Pourtalesia ceratopyga*, Clypeastroid-like pedicellaria (Pl. XLV. fig. 53).
„ 19. „ „ small large-headed pedicellaria (Pl. XLV. fig. 59).
„ 20. „ „ younger stage of same.
„ 21. „ „ rudimentary spine.
„ 22. „ „ rudimentary spine.
„ 23. „ „ tip of flattened interambulacral spine.
„ 24. *Pourtalesia carinata*, large-headed, hooked pedicellaria (Pl. XLV. figs. 46, 47).
„ 25. „ „ four-valved pedicellaria.
„ 26. *Aceste bellidifera*, large, short-stemmed, single-hooked pedicellaria (Pl. XLII. fig. 45).
„ 27. *Aceste bellidifera*, small, short-headed pedicellaria (Pl. XLV. fig. 46).
„ 28. „ „ small-based, long-pronged, pedicellaria.

PLATE XLIII.

PEDICELLARIÆ (figs. 1–26).

Fig. 1. *Phormosoma hoplacantha*, one of the large cup-bearing pedicellaria (Pl. XLIV. fig. 29).
„ 2. *Asthenosoma grubii*, long-stemmed, small-headed pedicellaria.
„ 3. *Echinolampas oviformis*, Clypeastroid-like pedicellaria (Pl. XLIV. fig. 41).
„ 4. *Echinolampas oviformis*, different view of same Clypeastroid-like pedicellaria (Pl. XLIV. fig. 41).
„ 5. *Echinolampas oviformis*, slender-pronged tridactyle pedicellaria.
„ 6. *Linopneustes murrayi*, large-headed pedicellaria (Pl. XLV. fig. 11).
„ 7. „ „ large-headed pedicellaria (Pl. XLV. fig. 13).
„ 8. „ „ short-headed, long-stemmed pedicellaria (Pl. XLV. fig. 14).
„ 9. *Cystechinus vesica*, large-headed pedicellaria (Pl. XLV. fig. 36).
„ 10. „ „ long-headed pedicellaria.
„ 11. „ „ long-headed pedicellaria somewhat older.
„ 12. „ „ Clypeastroid-like pedicellaria (Pl. XLV. fig. 35).
„ 13. *Genicopatagus affinis*, large-headed pedicellaria (Pl. XLV. figs. 20, 20′).
„ 14. *Echinocrepis cuneata*, large-headed pedicellaria (Pl. XLV. figs. 44, 45).
„ 15. *Pourtalesia ceratopyga*, large-headed pedicellaria (Pl. XLV. figs. 57, 58).
„ 16. „ „ large Clypeastroid-like pedicellaria (Pl. XLV. fig. 53).
„ 17. „ „ small Clypeastroid-like pedicellaria (Pl. XLV. fig. 54).

Fig. 18. *Pourtalesia laguncula*, large Clypeastroid-like pedicellaria, profile.
„ 19. „ „ full view facing one of the valves of same.
„ 20. *Pourtalesia carinata*, large-headed pedicellaria.
„ 21, 22, 23. *Pourtalesia carinata*, Clypeastroid-like pedicellaria; different views.
„ 24. *Calymne relicta*, large-based, Clypeastroid-like pedicellaria (Pl. XLIV. figs. 47, 48).
„ 25. *Aceste bellidifera*, large-headed pedicellaria (Pl. XLIV. fig. 46).
„ 26. *Schizaster japonicus*, large-headed pedicellaria.

PLATE XLIV.

Pedicellariæ (figs. 1–48).

Fig. 1. *Goniocidaris canaliculata*, interior view of a single valve of one of the short-headed, long-stemmed ambulacral pedicellariæ.
„ 2. *Goniocidaris canaliculata*, profile of a valve of a short-stemmed globular abactinal pedicellaria.
„ 3. *Goniocidaris canaliculata*, upper part of rod of a long-stemmed pedicellaria.
„ 4. *Goniocidaris florigera*, interior view of a prong of the globular-headed, short-stemmed pedicellariæ.
„ 5. *Goniocidaris florigera*, general view of the head of short-stemmed globular-headed interambulacral pedicellariæ.
„ 6. *Porocidaris elegans*, interior view of single valve of one of the large-headed, short-stemmed interambulacral pedicellariæ.
„ 7, 8. *Porocidaris elegans*, interior view of valves of smaller pedicellariæ.
„ 9. Profile of fig. 8.
„ 10. *Porocidaris elegans*, interior view of valve of short-stemmed, short-headed, abactinal pedicellaria.
„ 11. *Porocidaris elegans*, interior view of large-headed, short-stemmed interambulacral pedicellariæ.
„ 12. Base of rod supporting valve of fig. 6.
„ 13. Base of rod supporting valve of fig. 11.
„ 14. Extremity of rod supporting valve of fig. 11.
„ 15. *Aspidodiadema tonsum*, valve of long-headed, long-stemmed pedicellaria, seen from the interior.
„ 16. *Aspidodiadema microtuberculatum*, magnified portion of secondary spines.
„ 17. „ „ head of rod supporting long-headed, long-stemmed pedicellaria.

Fig. 18. *Aspidodiadema microtuberculatum*, valve seen from the interior of globular-headed, short-stemmed abactinal pedicellariæ.

„ 19. *Phormosoma tenue*, valve of long-headed pedicellaria, seen from the interior.

„ 20. „ „ valve of smaller pedicellaria of same kind as fig. 19, seen from exterior.

„ 21. *Phormosoma tenue*, small, bottle-shaped, didactyle pedicellaria.

„ 22. „ „ single valve of same as fig. 21, seen from interior.

„ 23. „ „ valve of still smaller pedicellaria than fig. 20, and of same kind, seen from interior.

„ 24. *Phormosoma tenue*, upper extremity of rod supporting the long-headed pedicellariæ.

„ 25. *Phormosoma luculentum*, interior view of single valve of globular-headed short-stemmed pedicellaria.

„ 26. Exterior view of the valve of fig. 25.

„ 27. *Phormosoma luculentum*, profile of single valve of small short-headed, short-stemmed pedicellaria.

„ 28. *Phormosoma hoplacantha*, upper extremity of rod supporting long-headed pedicellariæ.

„ 29. *Phormosoma hoplacantha*, single valve seen from exterior of one of the cupped pedicellariæ.

„ 29′. *Phormosoma hoplacantha*, interior view of same pedicellaria showing the trough extending to the base of the pedicellariæ from the edges of the lip of the cup of the extremity of the valve.

„ 30. *Phormosoma hoplacantha*, interior view of base of one of the same pedicellariæ.

„ 31. „ „ upper extremity of rod supporting the above pedicellaria of fig. 29.

„ 32. *Asthenosoma grubii*, upper extremity of rod of large-headed pedicellaria.

„ 33. „ „ magnified view of one of the sheathed spines denuded.

„ 34. „ „ interior view of valve of short-headed, globular abactinal pedicellaria.

„ 35. *Asthenosoma grubii*, upper end of rod supporting long-headed, long-stemmed pedicellariæ.

„ 36. *Asthenosoma grubii*, interior view of valve of large-headed pedicellaria.

„ 37. *Micropyga tuberculata*, profile view of large-headed pedicellaria.

„ 38. *Pseudoboletia indiana*, interior view of large short-stemmed single-hooked pedicellaria.

„ 39. *Pseudoboletia indiana*, interior view of large-headed, short-stemmed pedicellaria.

„ 40. „ „ extremity of rod supporting large-headed pedicellaria.

„ 41. *Echinolampas oviformis*, single valve of Clypeastroid-like pedicellaria.

Fig. 42. *Echinolampas oviformis,* extremity of pointed spine, interambulacral spine (enlarged).
,, 43. *Echinolampas oviformis,* upper extremity of rod supporting the pedicellariæ of fig. 41.
,, 44. *Echinolampas oviformis,* enlarged view of upper extremity of fan-shaped interambulacral spine.
,, 45. *Aceste bellidifera,* interior view of large, short-stemmed, single-hooked pedicellaria.
,, 46. ,, ,, interior view of small short-headed pedicellaria.
,, 47. *Calymne relicta,* single valve of Clypeastroid-like pedicellaria.
,, 48. ,, ,, upper extremity of spiny rod supporting the same.

PLATE XLV.

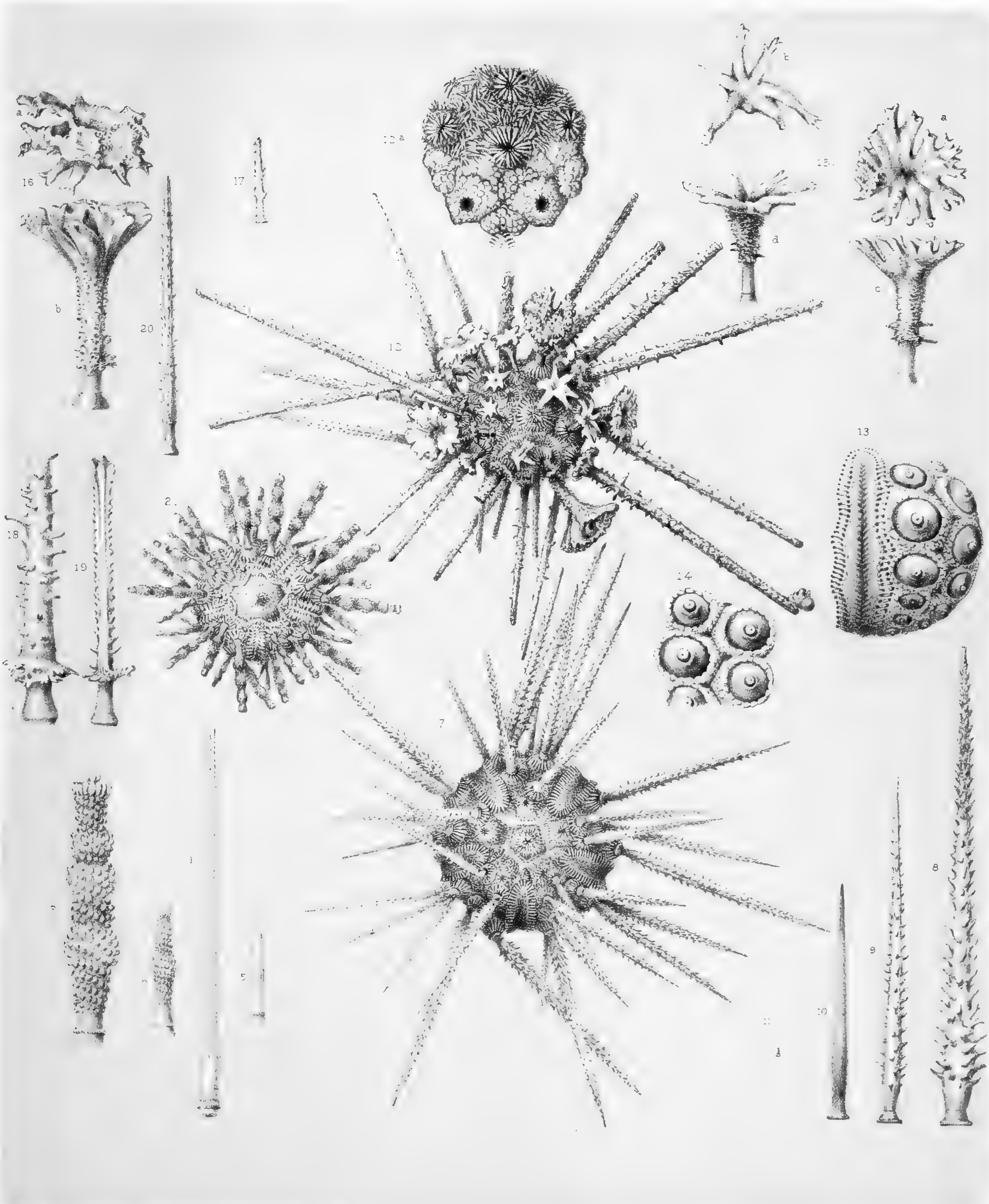
Pedicellariæ (figs. 1–59).

Fig. 1. *Cœlopleurus maillardi,* interior view of single valve of large-headed, long-stemmed pedicellaria.
,, 2. Profile of same as fig. 1.
,, 3. *Cœlopleurus maillardi,* interior view of globular, short-headed, short-stemmed interambulacral pedicellaria.
,, 4. Profile of same as fig. 3.
,, 5, 6. *Cœlopleurus maillardi,* upper extremities of rods supporting the pedicellariæ.
,, 7. *Schizaster japonicus,* interior view of large-headed, interambulacral abactinal pedicellaria.
,, 8. *Schizaster japonicus,* exterior view of same as fig. 7.
,, 9. ,, ,, profile of a similar pedicellaria, somewhat smaller.
, 10. ,, ,, upper extremity of rod supporting these pedicellariæ.
,, 11. *Linopneustes murrayi,* interior view of large-headed, short-stemmed pedicellaria.
,, 12. *Linopneustes murrayi,* profile view of another pedicellaria of the same kind.
,, 13. ,, ,, profile of a more elongate pedicellaria.
,, 13′. Interior view of another still larger pedicellaria of the same kind.
,, 14. Single valve, profile view of the short-headed, long-stemmed pedicellariæ.
,, 15. *Linopneustes murrayi,* general view of a short-headed pedicellaria.
,, 16. Interior view of valve of same as fig. 15.
,, 17. *Linopneustes murrayi,* interior view of base of large-headed pedicellaria (like fig. 11), but more serrate.
,, 18, 19. *Linopneustes murrayi,* upper extremity of rod supporting large-headed pedicellaria, with a magnified portion of same.

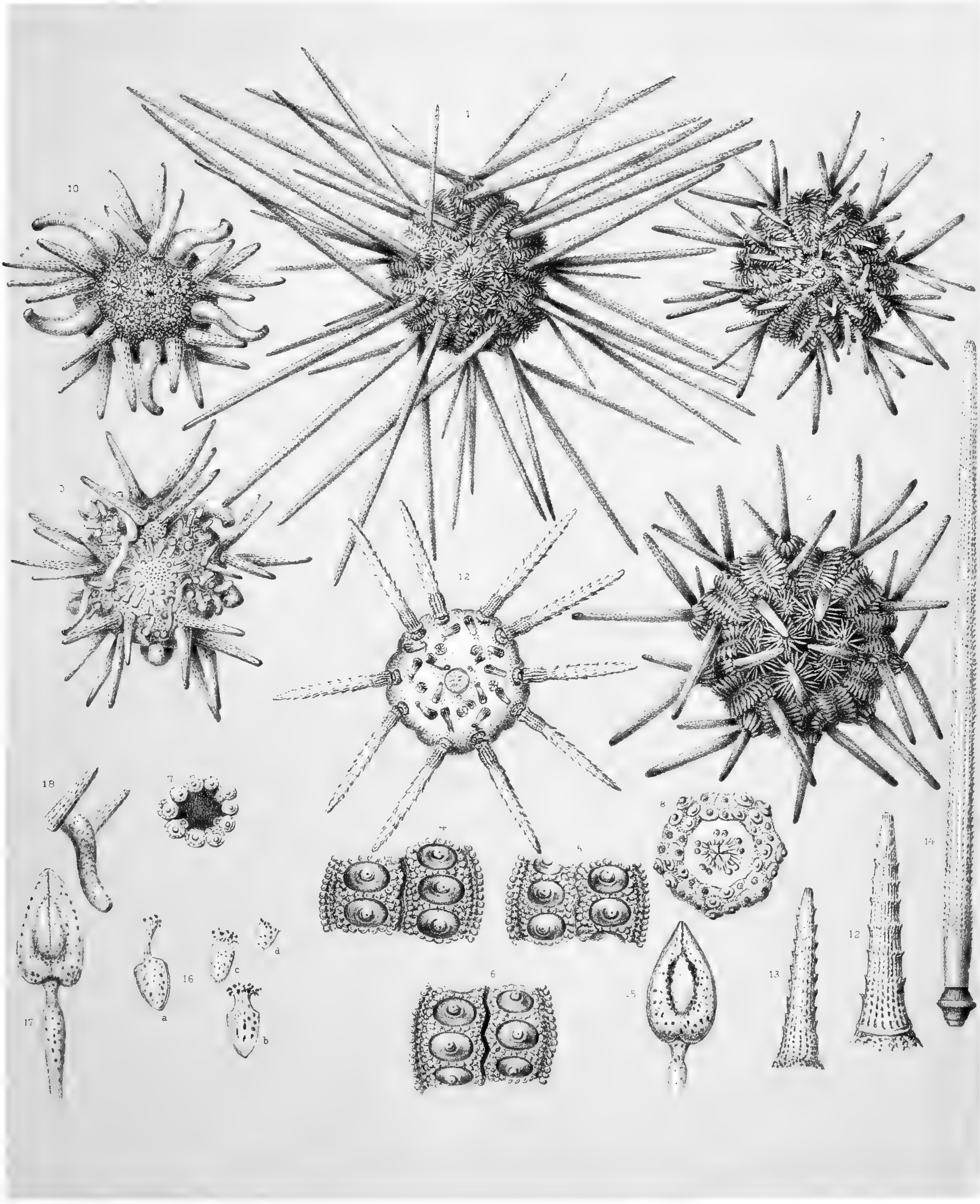
Fig. 20. *Genicopatagus affinis*, profile of large-headed, Spatangoid-like pedicellaria.
„ 20′. „ „ different view of another pedicellaria of same kind.
„ 21. „ „ interior view of base of same pedicellaria.
„ 22. „ „ magnified view of upper extremity of rod supporting pedicellariæ.
„ 23. *Genicopatagus affinis*, general view of upper extremity of rod.
„ 24. „ „ portion of shank of rod.
„ 25. *Cystechinus wyvillii*, magnified interambulacral spine.
„ 26. „ „ rod supporting the pedicellariæ of fig. 27.
„ 27. „ „ Clypeastroid-like pedicellaria.
„ 28. „ „ large-headed (Spatangoid-like) pedicellaria.
„ 29. *Cystechinus clypeatus*, one of the club-shaped interambulacral spines magnified.
„ 30. „ „ extremity of a large-headed, small pedicellaria, seen from the exterior.
„ 31. Tip of same as fig. 30; magnified.
„ 32. *Cystechinus vesica*, magnified view of interambulacral spine.
„ 33. „ „ tip of rod carrying the Clypeastroid-like pedicellaria of fig. 35.
„ 34. *Cystechinus vesica*, extremity of interambulacral primary spine; magnified.
„ 35. „ „ Clypeastroid-like pedicellaria.
„ 36. „ „ interior view of large-headed pedicellaria.
„ 37, 38. *Spatagocystis challengeri*, upper extremity of rods carrying large-headed pedicellariæ.
„ 39. *Spatagocystis challengeri*, profile of large-headed pedicellaria.
„ 40. „ „ interior view of base of same.
„ 41. „ „ interior view of large-based, slender-pronged pedicellaria.
„ 42. *Spatagocystis challengeri*, interior view of base of small-based, long-pronged pedicellaria.
„ 43. *Spatagocystis challengeri*, exterior view of short-headed, toothed, cup-pronged short-stemmed pedicellaria.
„ 44. *Echinocrepis cuneata*, profile of large-headed pedicellaria.
„ 45. „ „ extremity of rod carrying same.
„ 46. *Pourtalesia carinata*, profile of large-headed, coarsely-reticulated, hooked pedicellaria.
„ 47. Interior view of a pedicellaria of same kind as fig. 46.
„ 48. *Pourtalesia carinata*, large-headed pedicellaria, seen partly in profile.
„ 49. „ „ large-based, slender-pronged valve, seen from interior.
„ 50. „ „ another large-headed, closely-reticulated pedicellaria valve.

Fig. 51. *Pourtalesia carinata*, rod carrying the pedicellariæ of figs. 46, 47.
,, 52. ,, ,, magnified interambulacral abactinal spine.
,, 53. *Pourtalesia ceratopyga*, valve of large Clypeastroid-like pedicellaria.
,, 54. Valve of small pedicellaria of same kind as fig. 53.
,, 55. *Pourtalesia ceratopyga*, upper extremity of rod supporting the above.
,, 56. ,, ,, broad based, slender-pronged, and hooked pedicellaria.
,, 57. ,, ,, profile of large-headed coarsely-reticulated, hooked pedicellaria.
,, 58. Interior view of another pedicellaria of same kind as fig. 57.
,, 59. *Pourtalesia ceratopyga*, small, large-headed pedicellaria, with smooth valvular edge.

INDEX OF GENERA AND SPECIES.



1 CIDARIS (DOROCIDARIS) BRACTEATA, A. Ag. 2–6 CIDARIS TRIBULOIDES Bl.
7–20 GONIOCIDARIS FLORIGERA, A. Ag.



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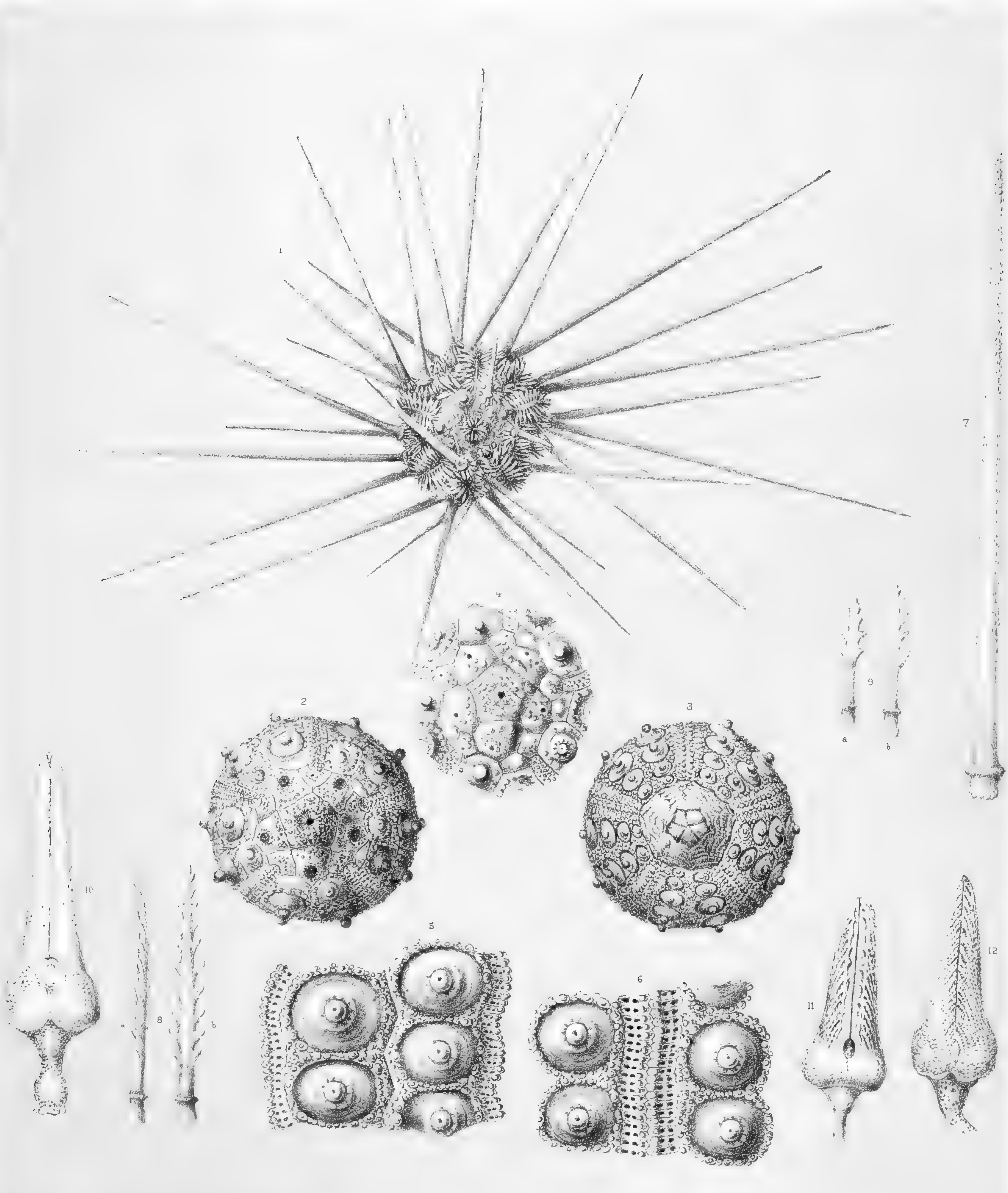

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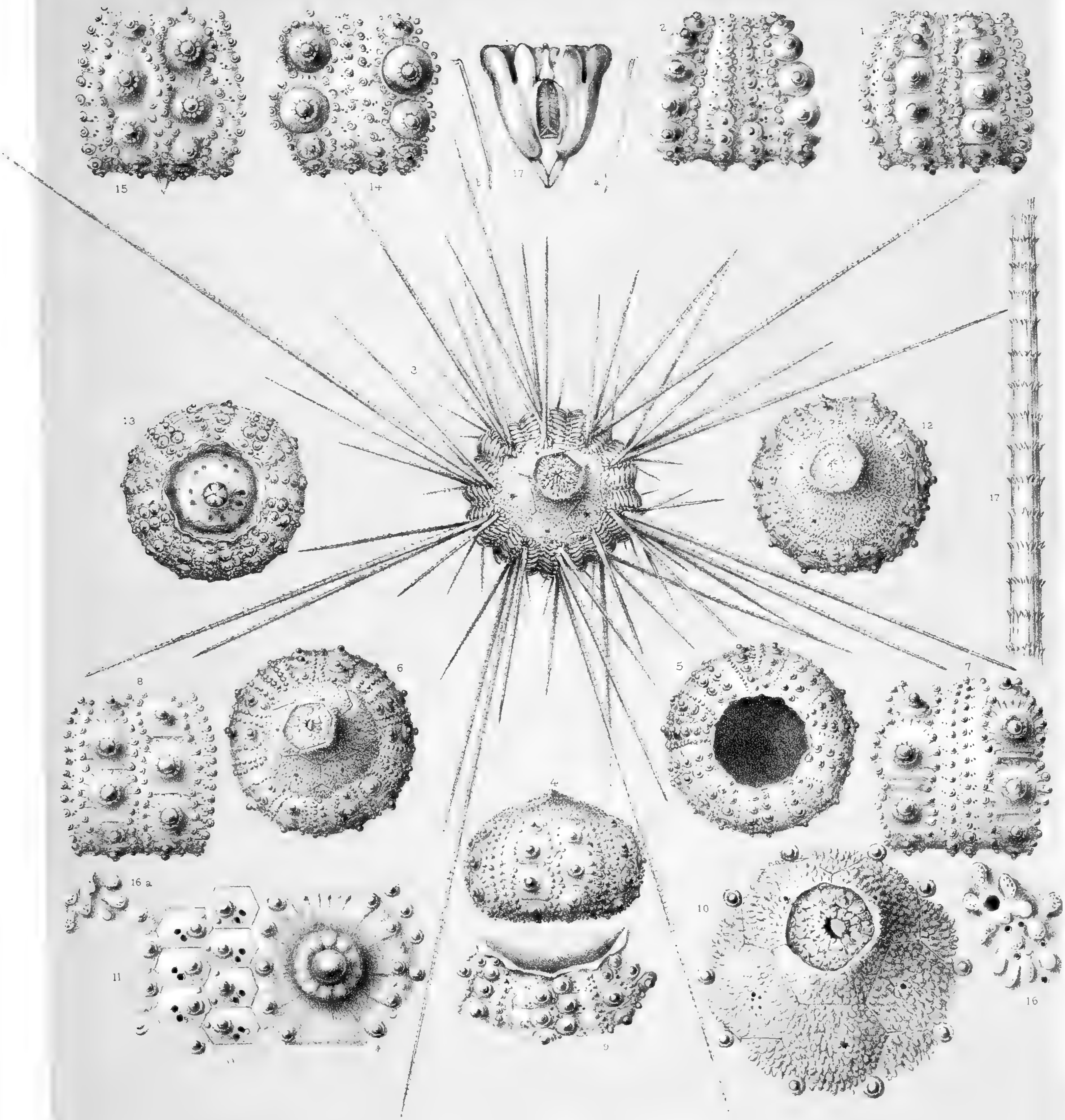
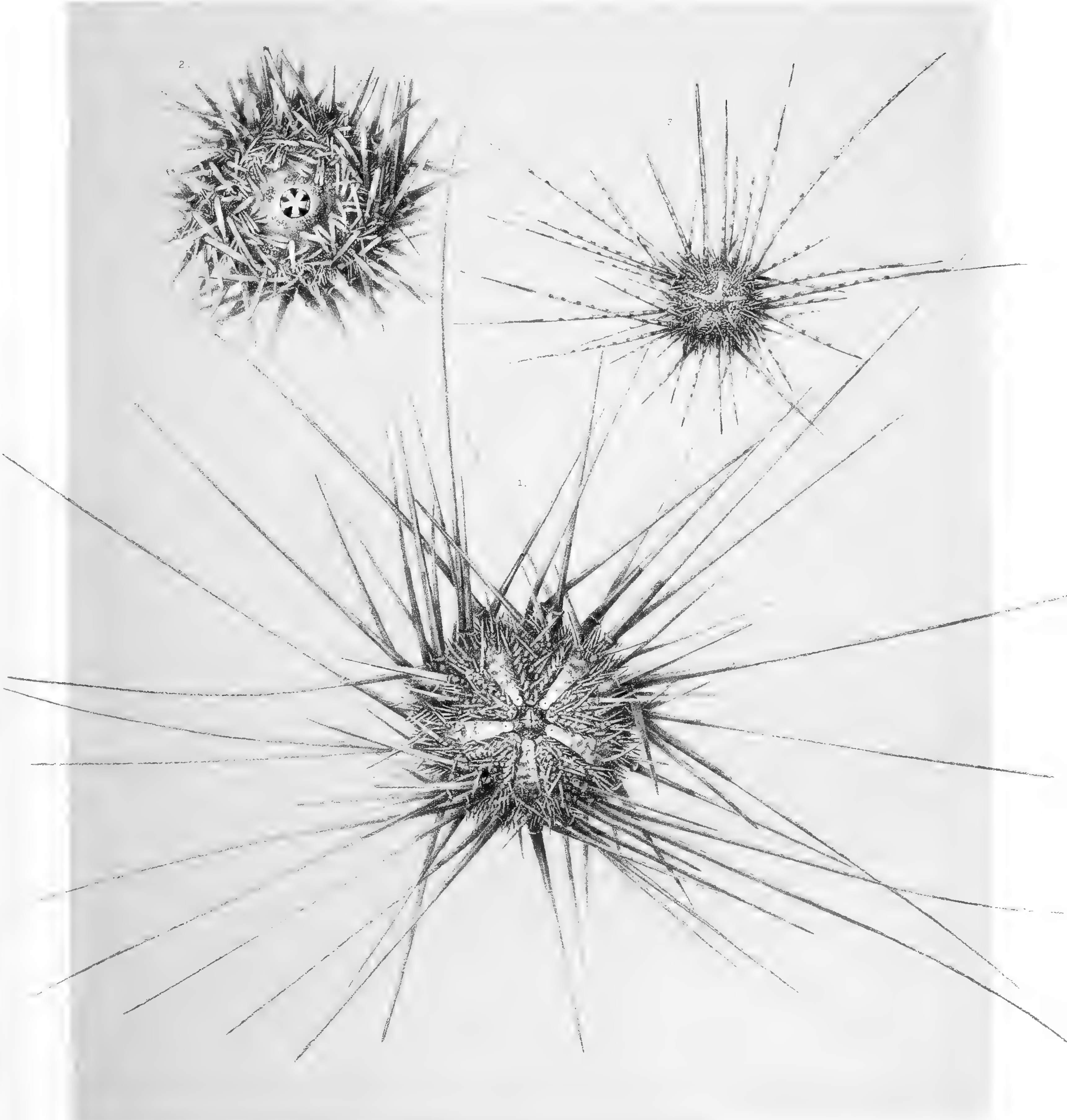


SALENIA VARISPINA. ... SALENIA HASTIGERA



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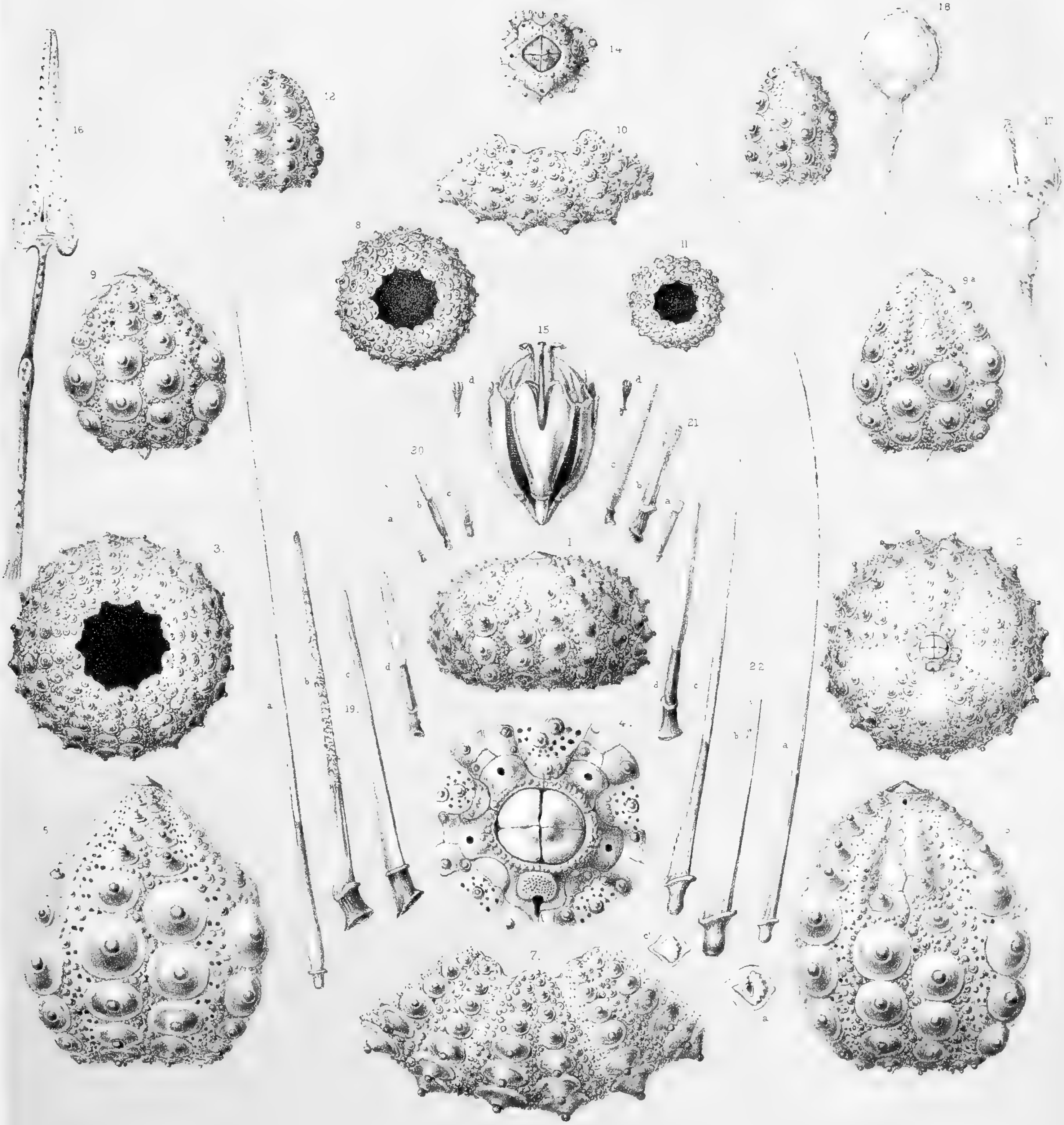

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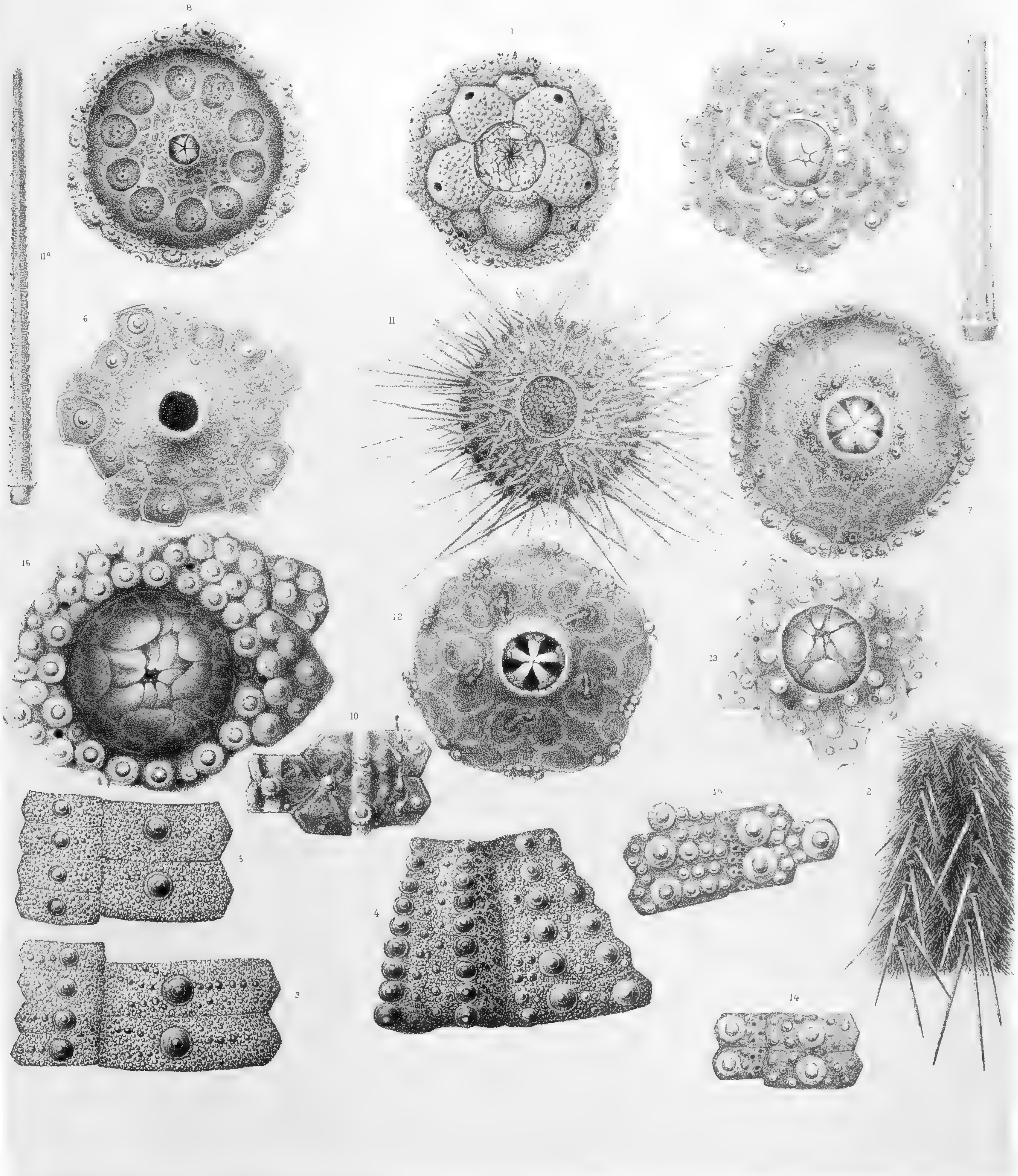
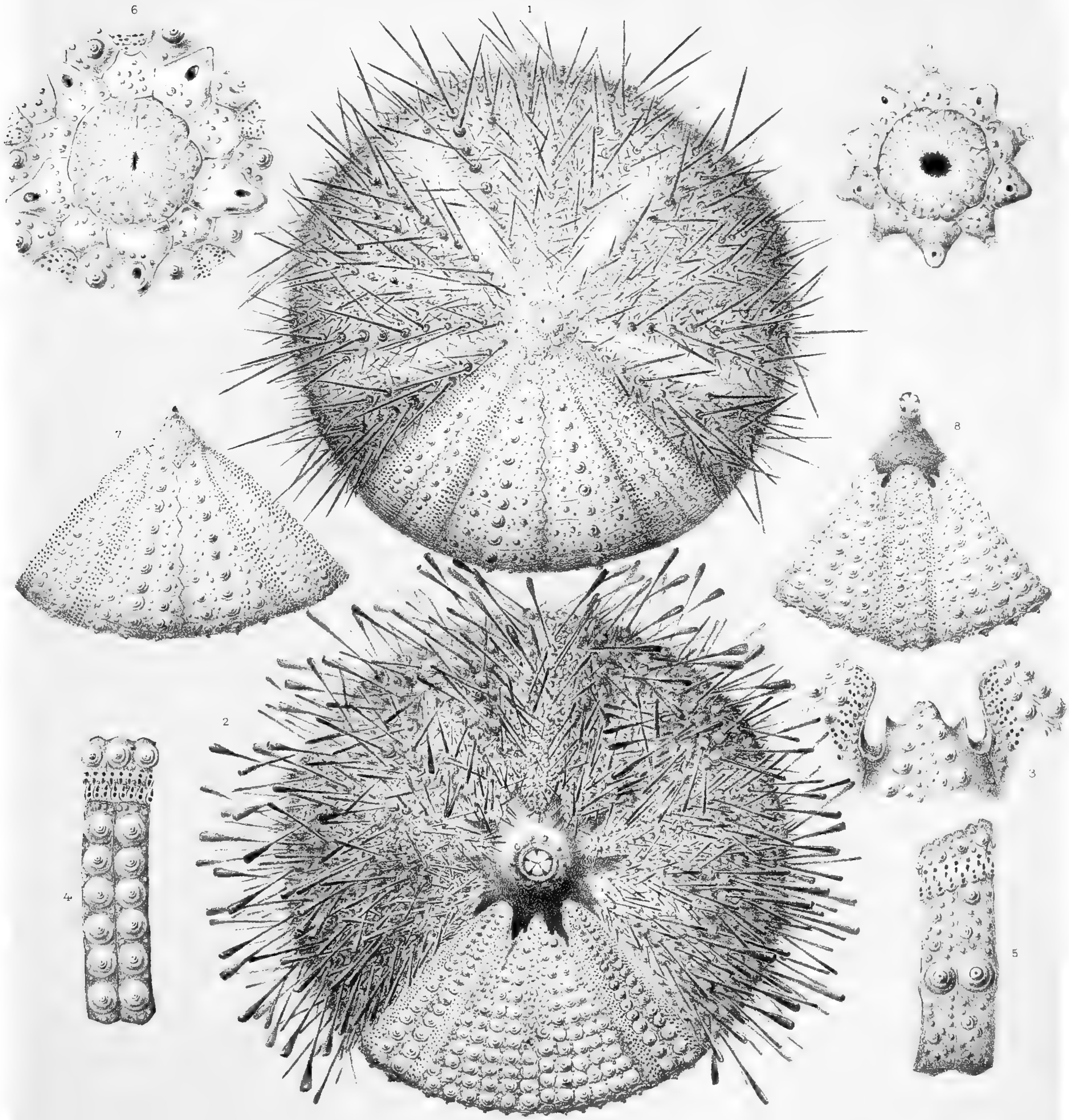


1-5 ECHINUS HORRIDUS. A. Ag. 6-7 MICROPYGA TUBERCULATA A. Ag. 8-10 TRIGONOCIDARIS MONOLINI A. Ag.
11-14 PRIONECHINUS SAGITTIGER A. Ag. 15-17 COTTALDIA FORBESIANA A. Ag.



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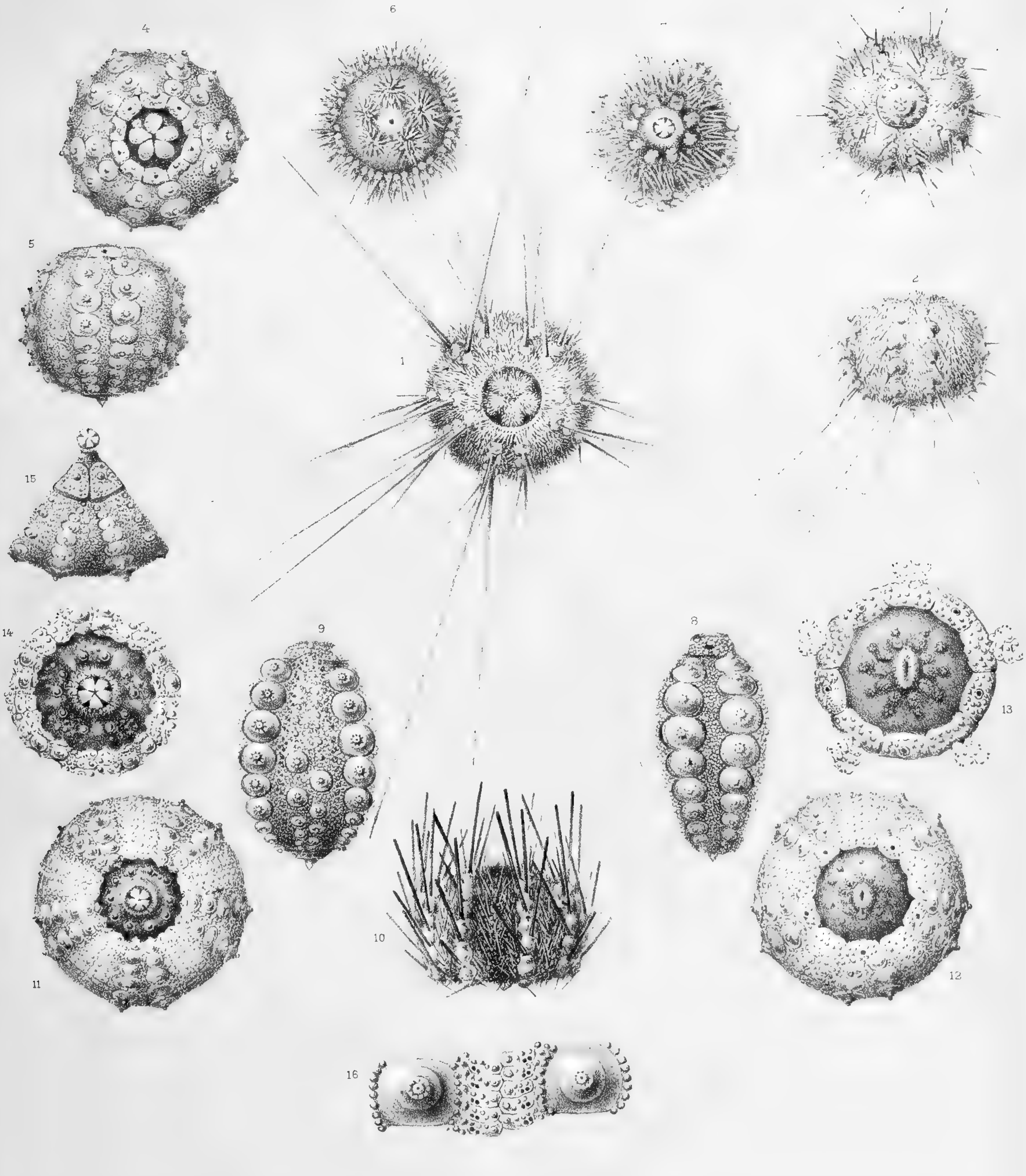

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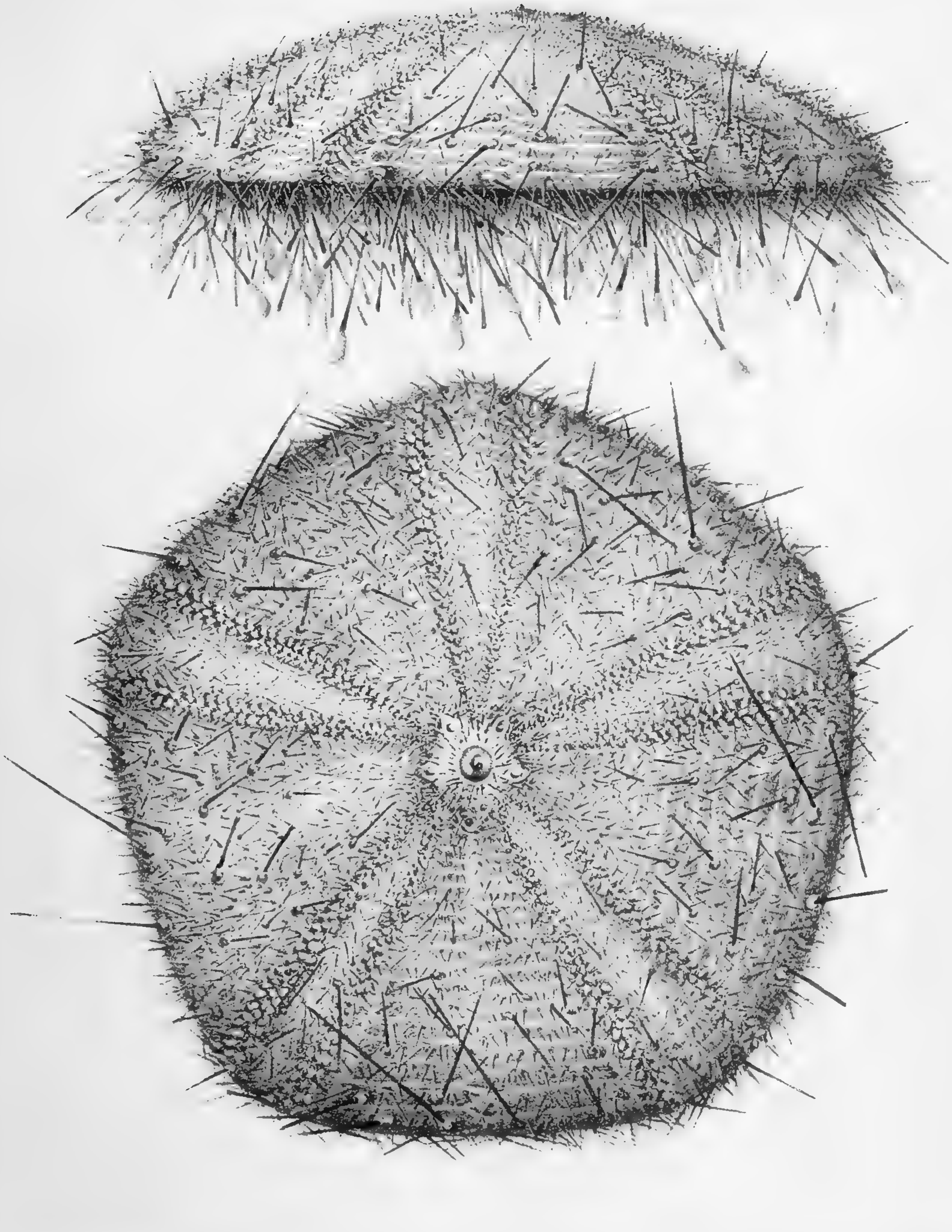

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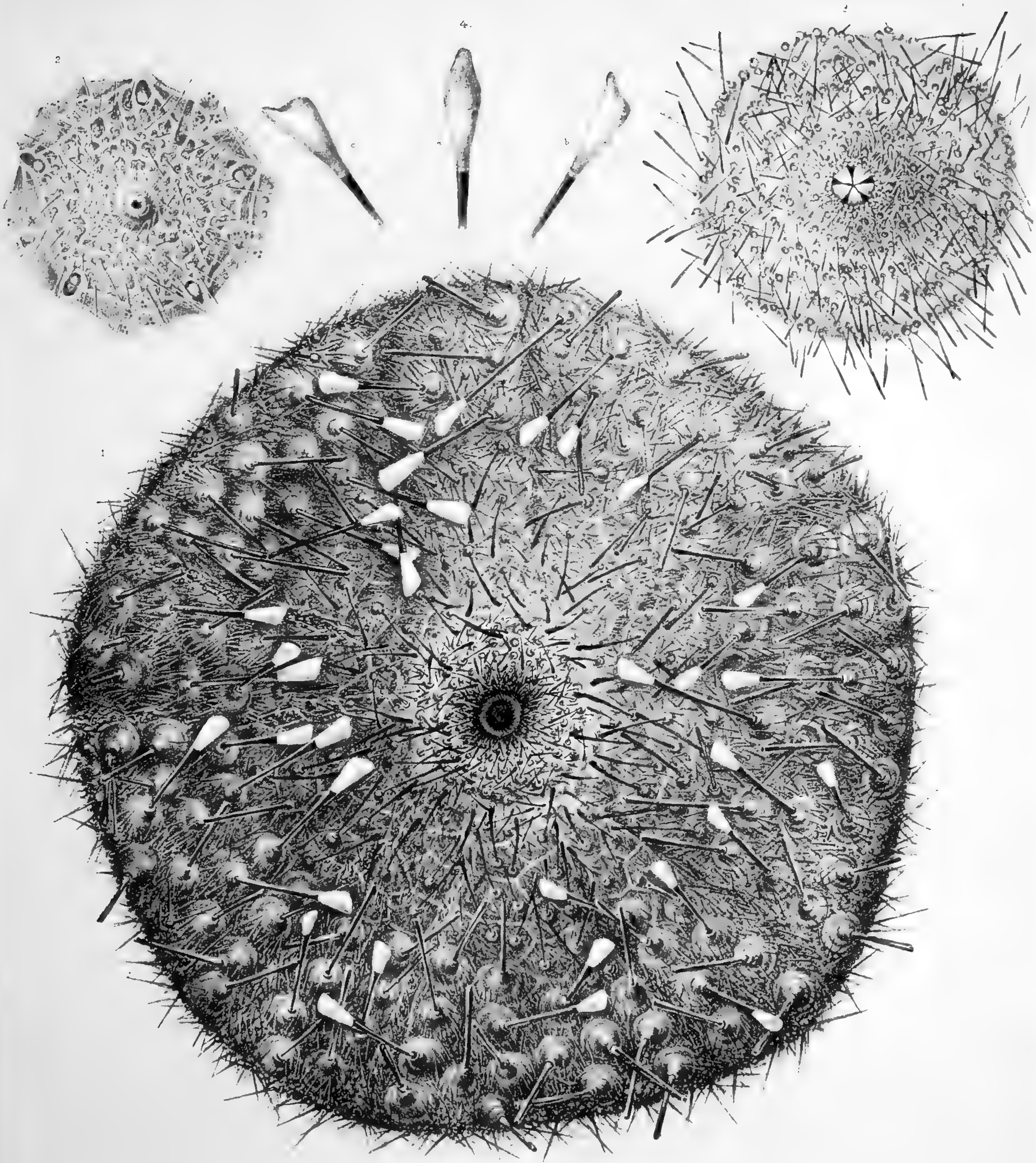

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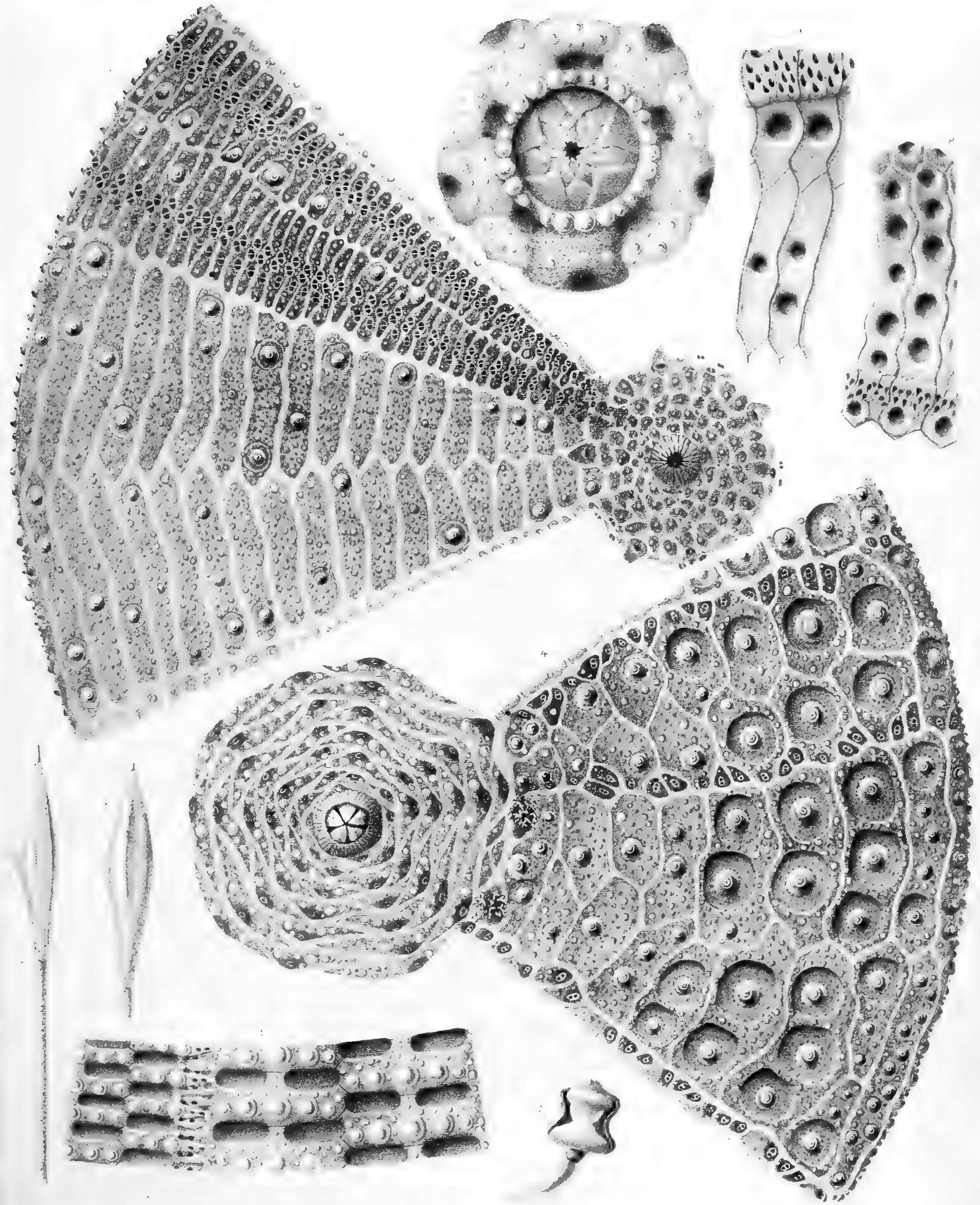

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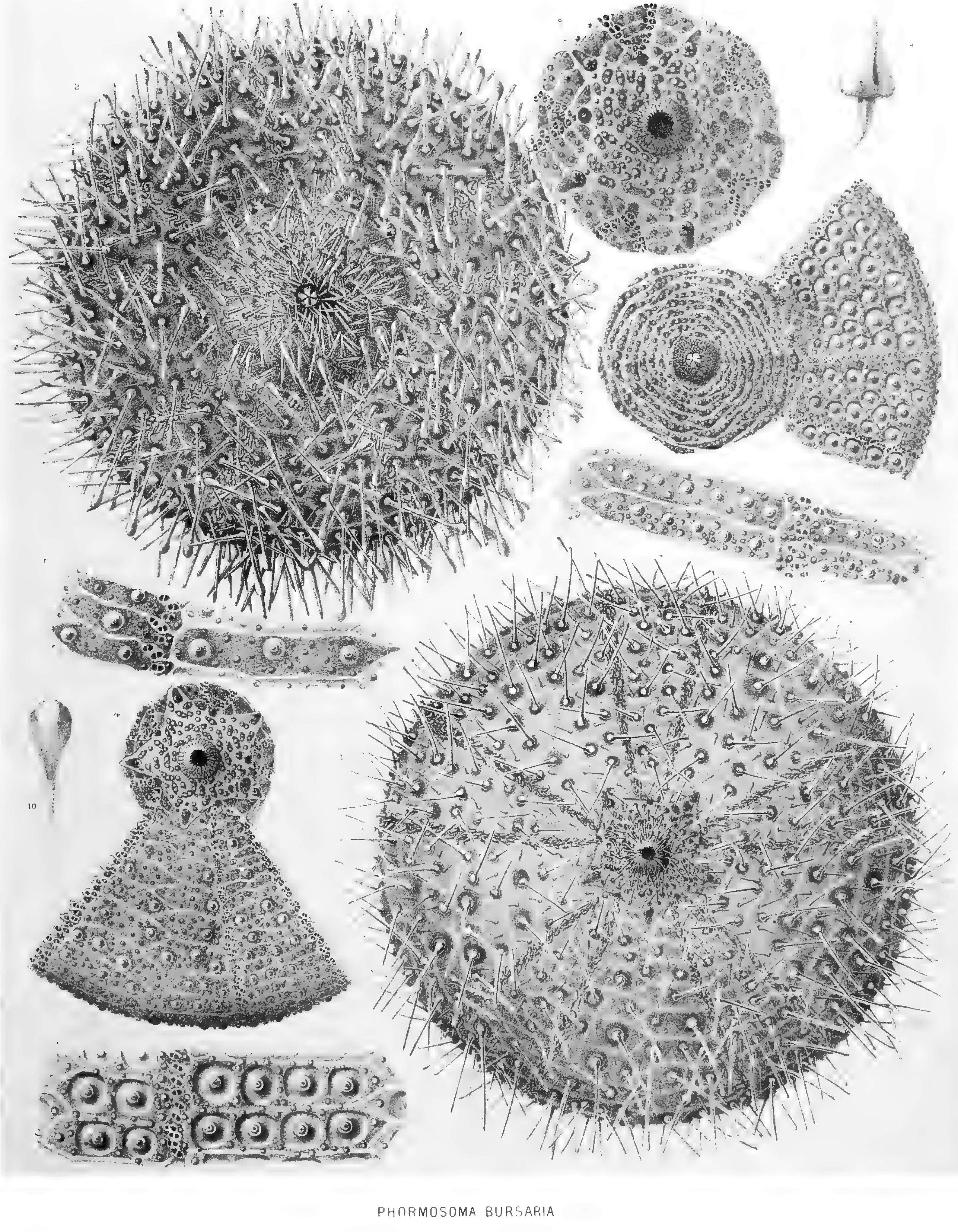

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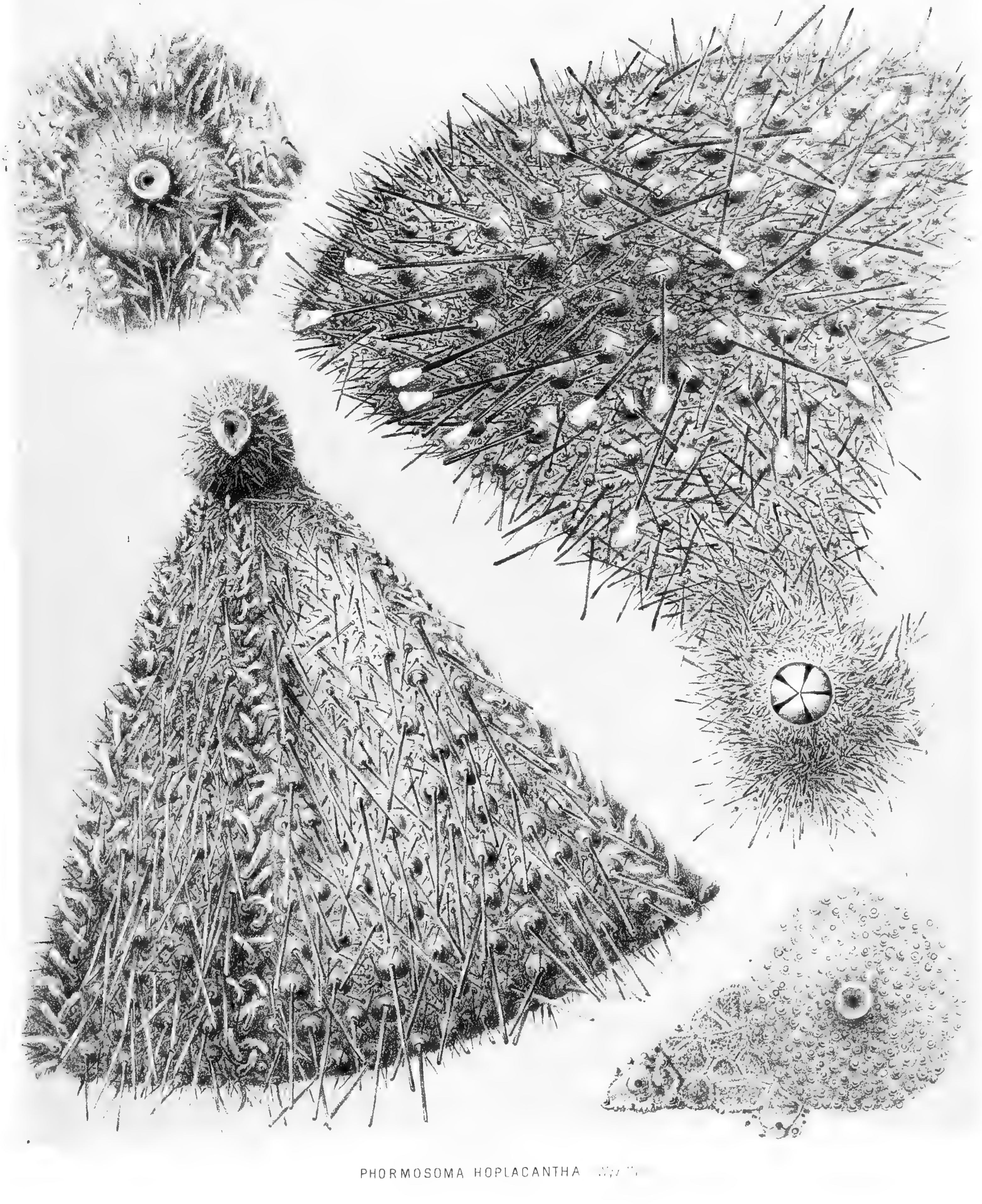

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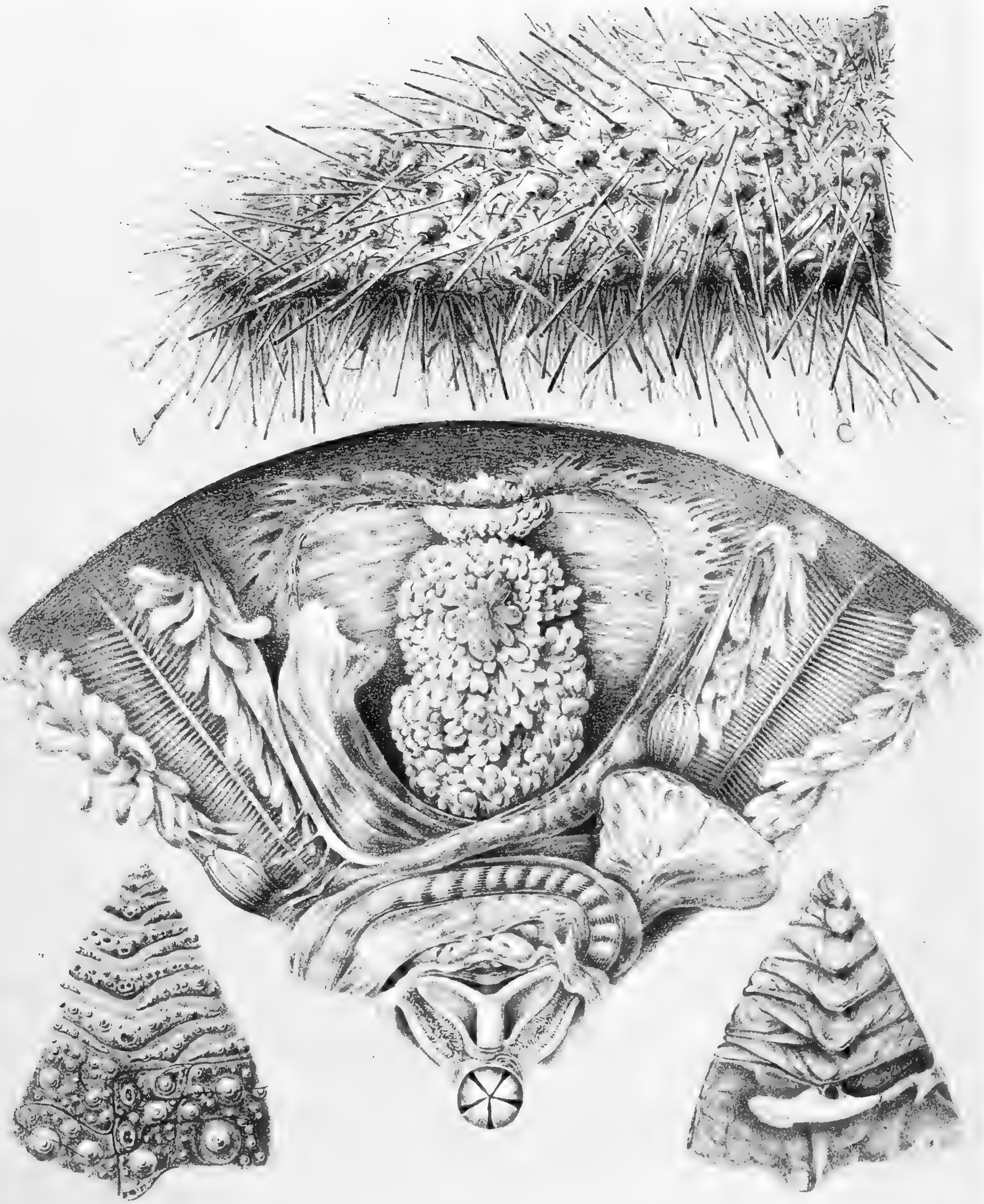

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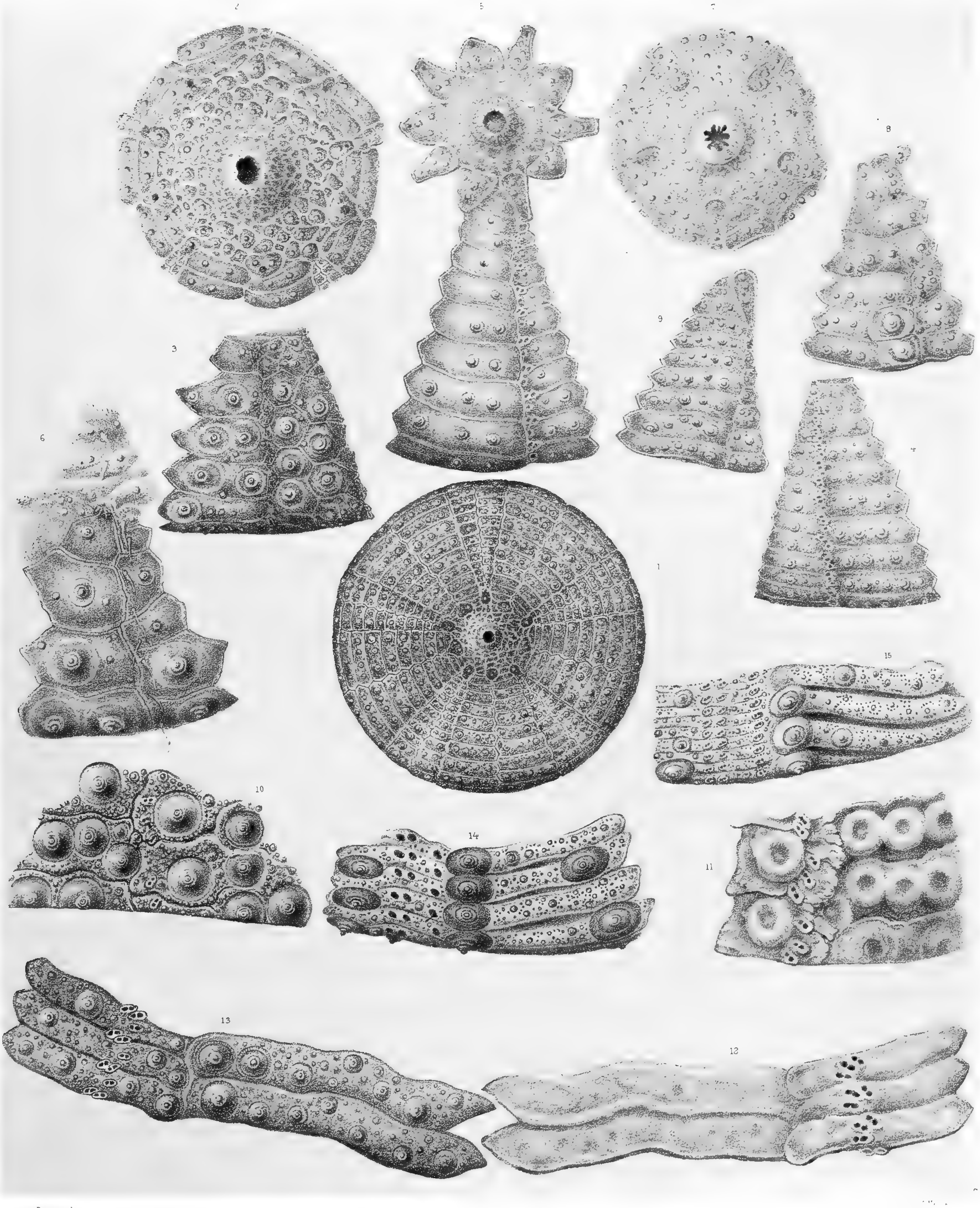

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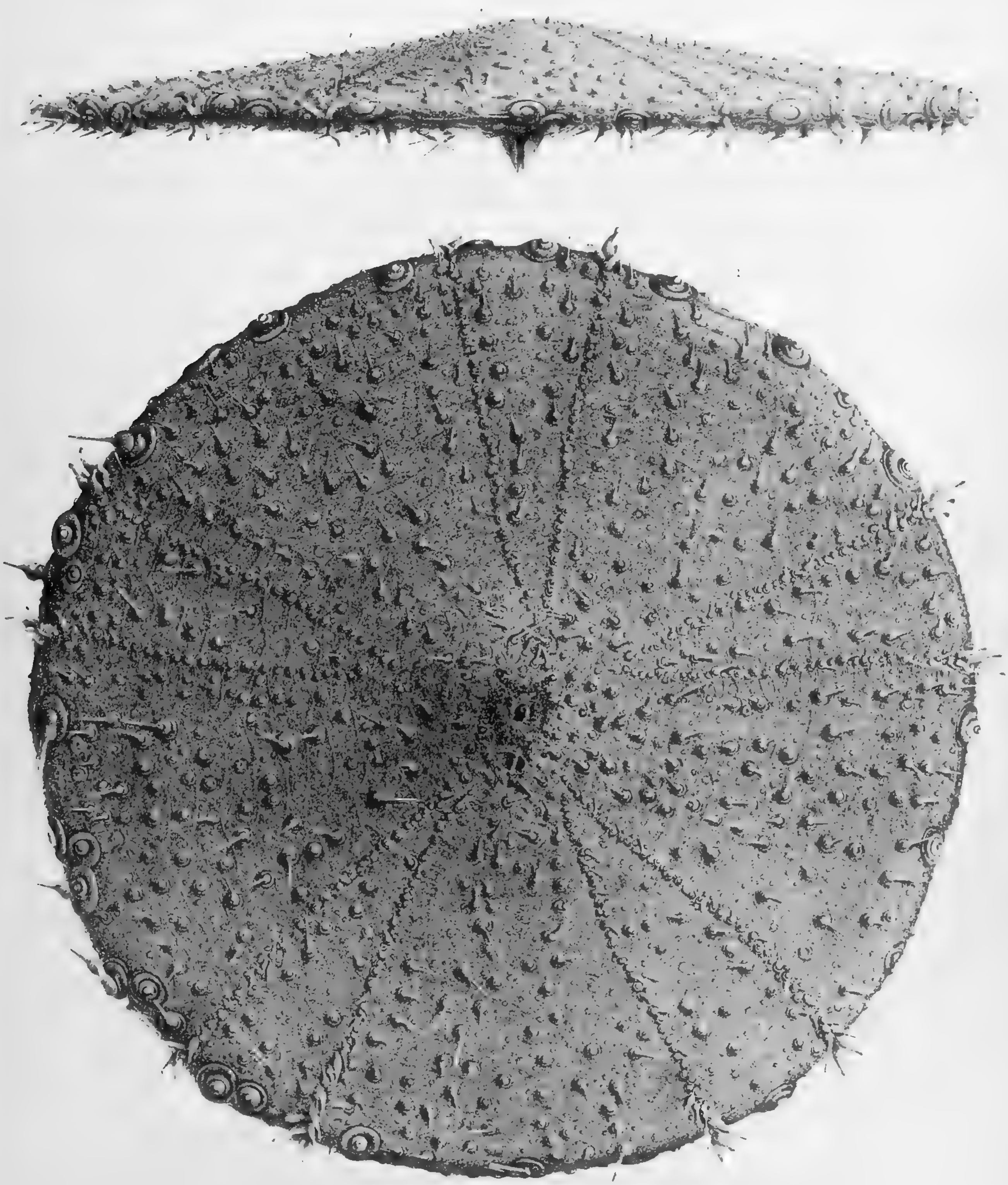
14, 15 ASTHENOSOMA TESSELLATA. A. Ag.



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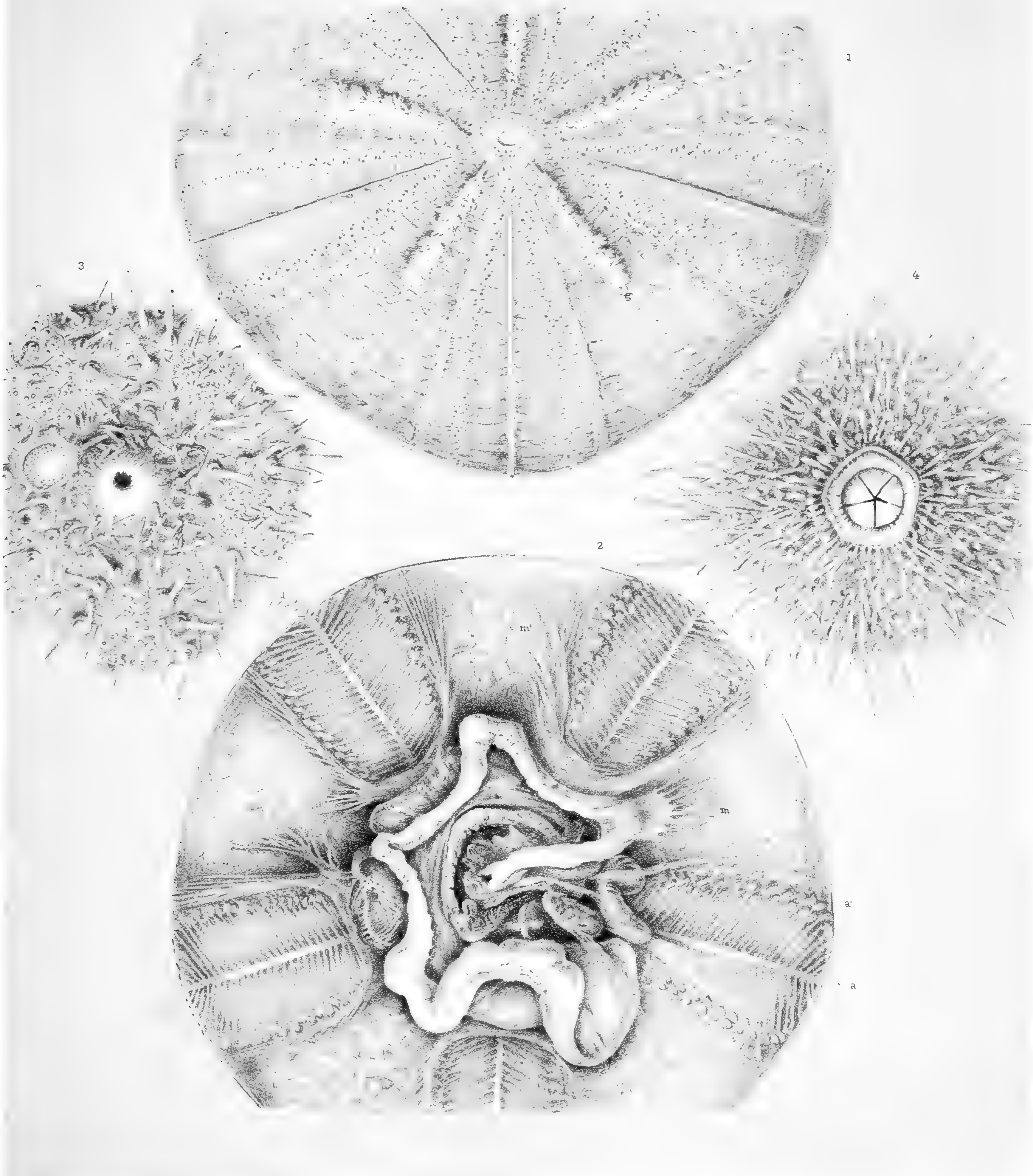

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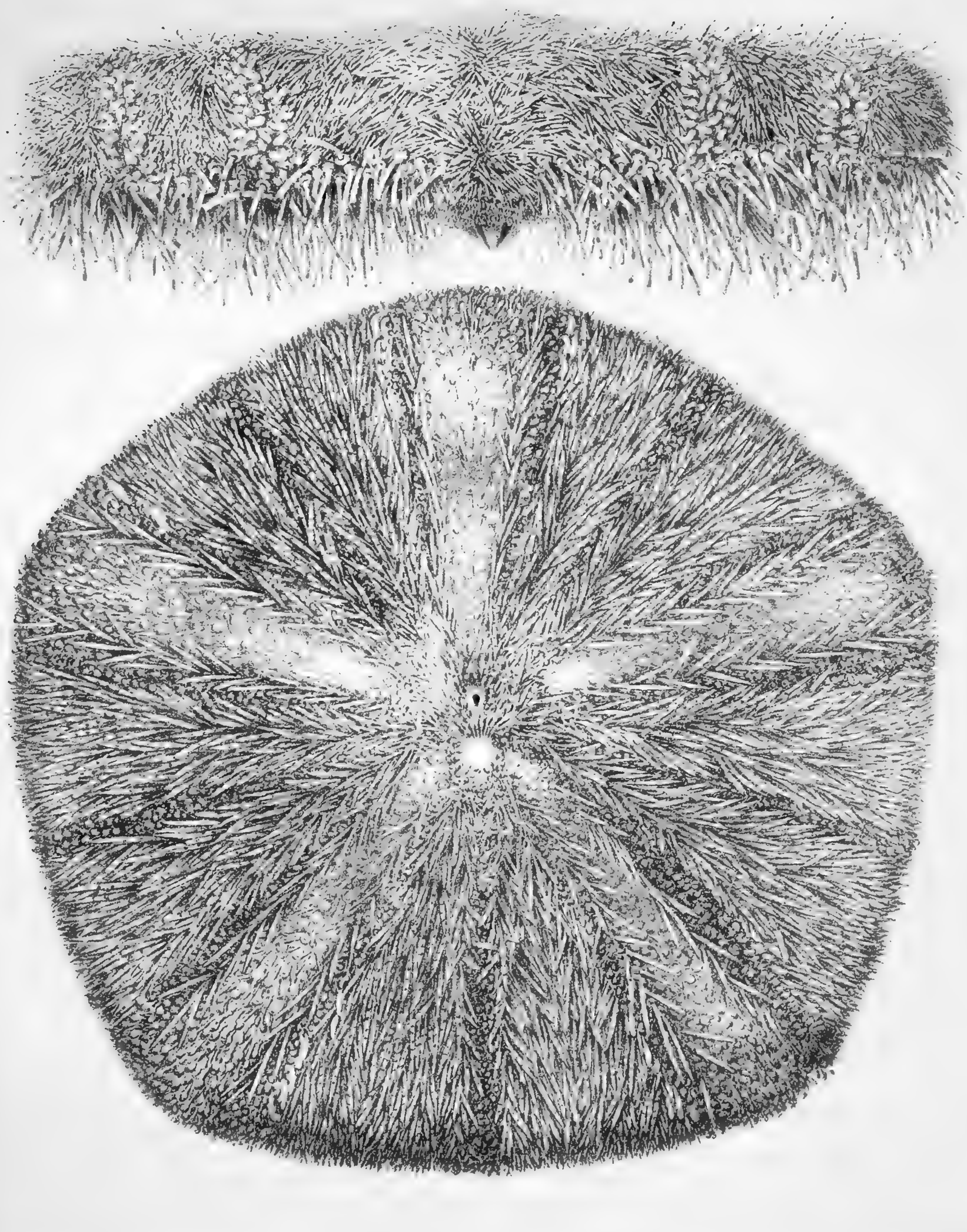

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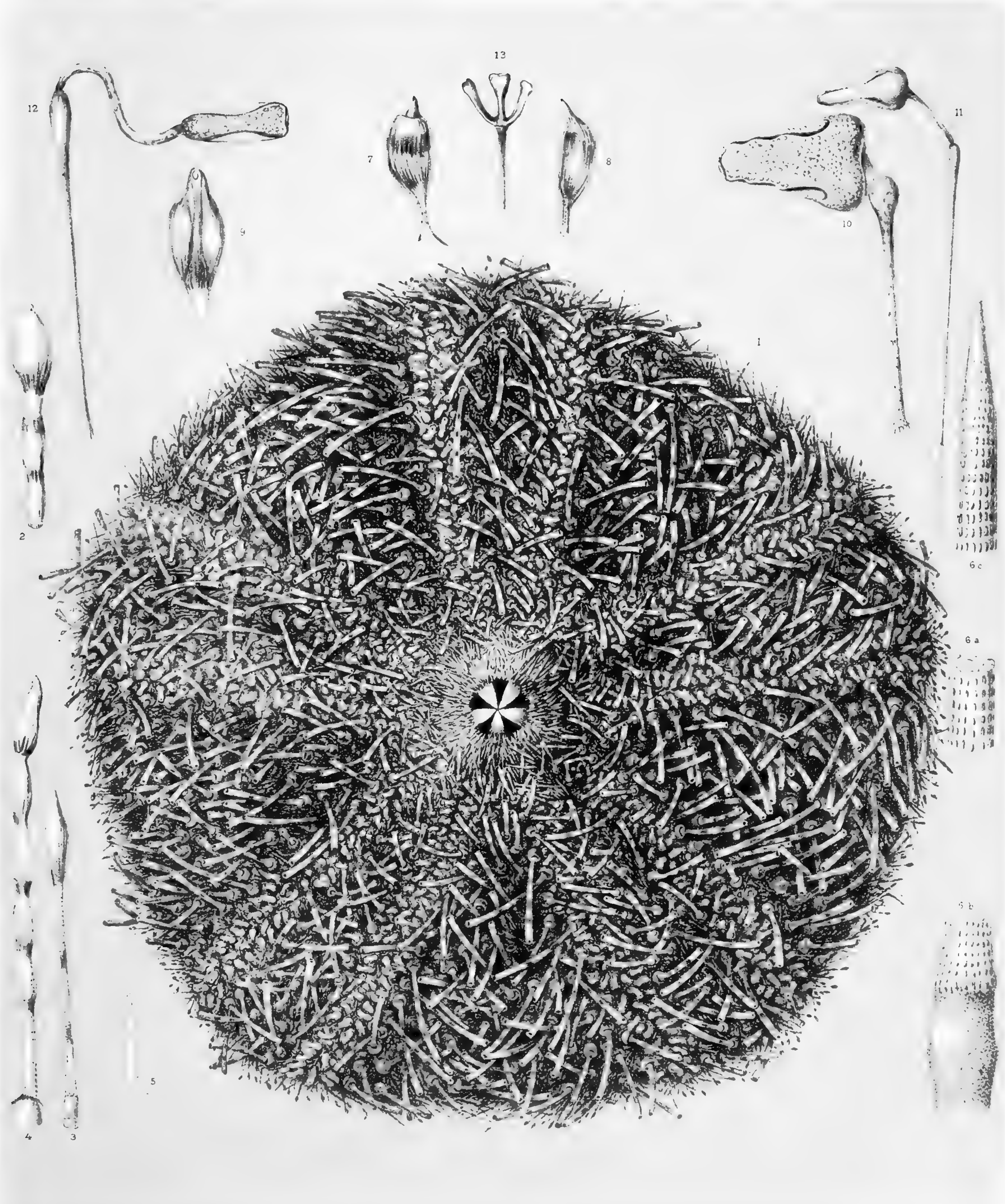

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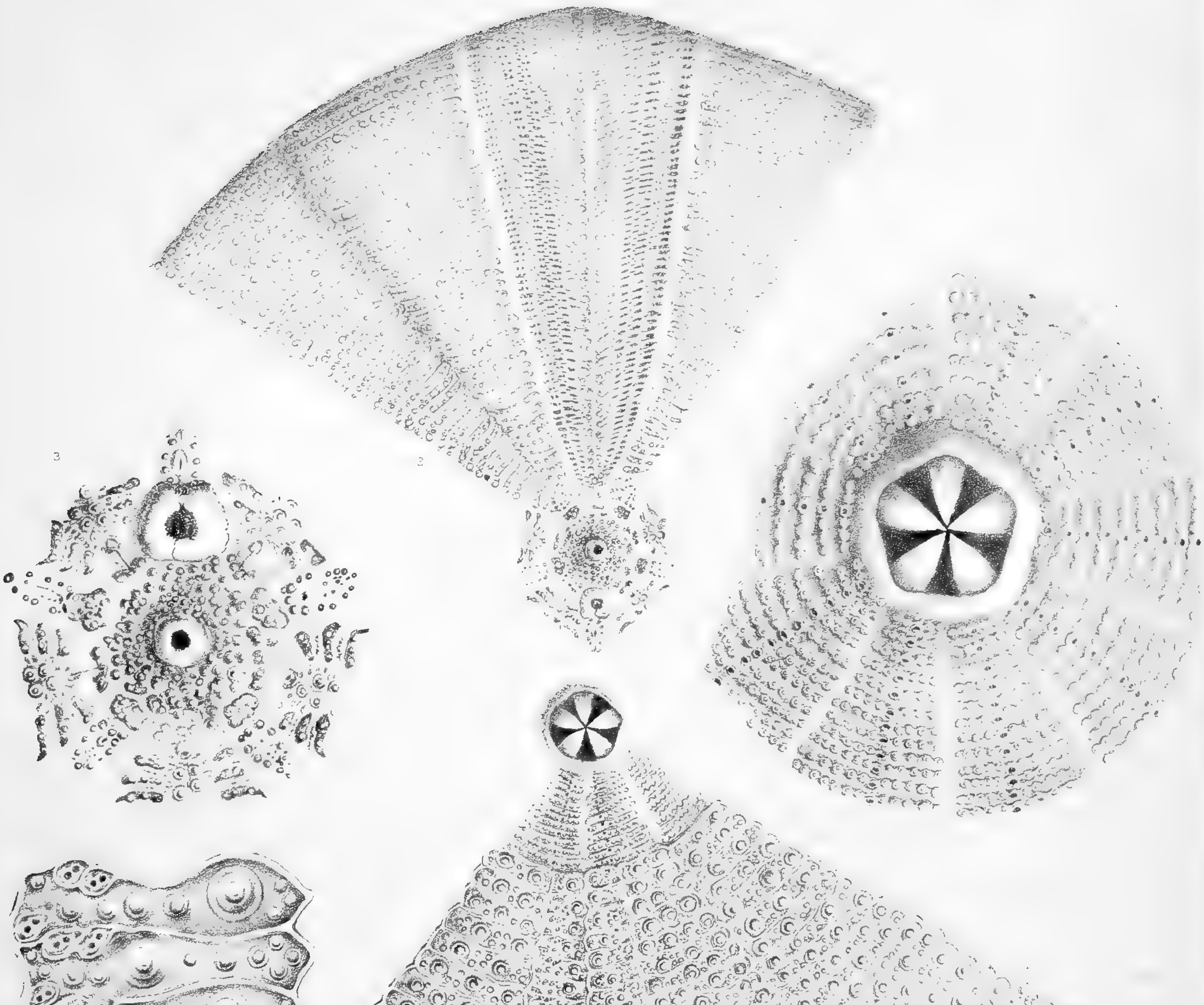

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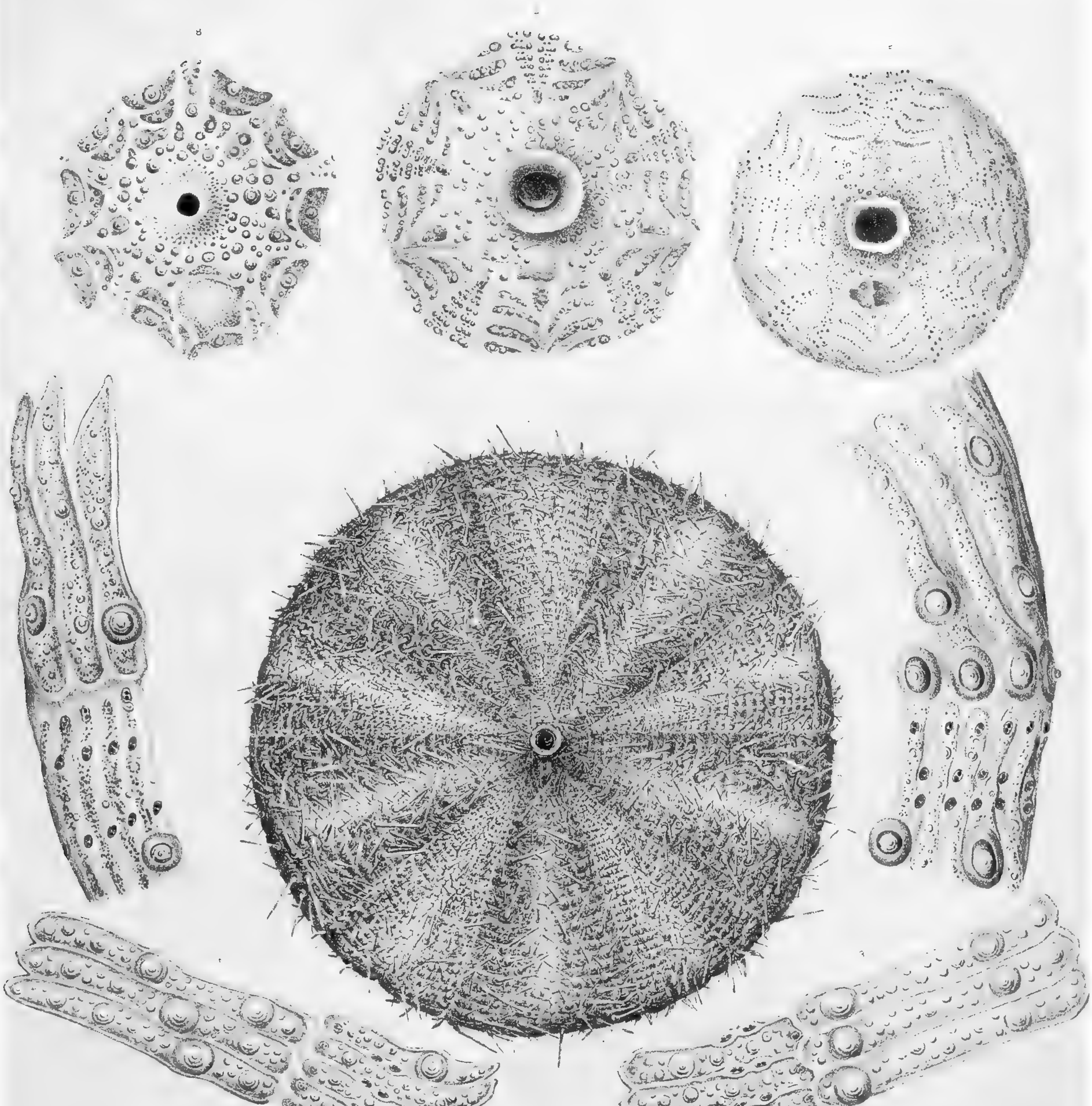
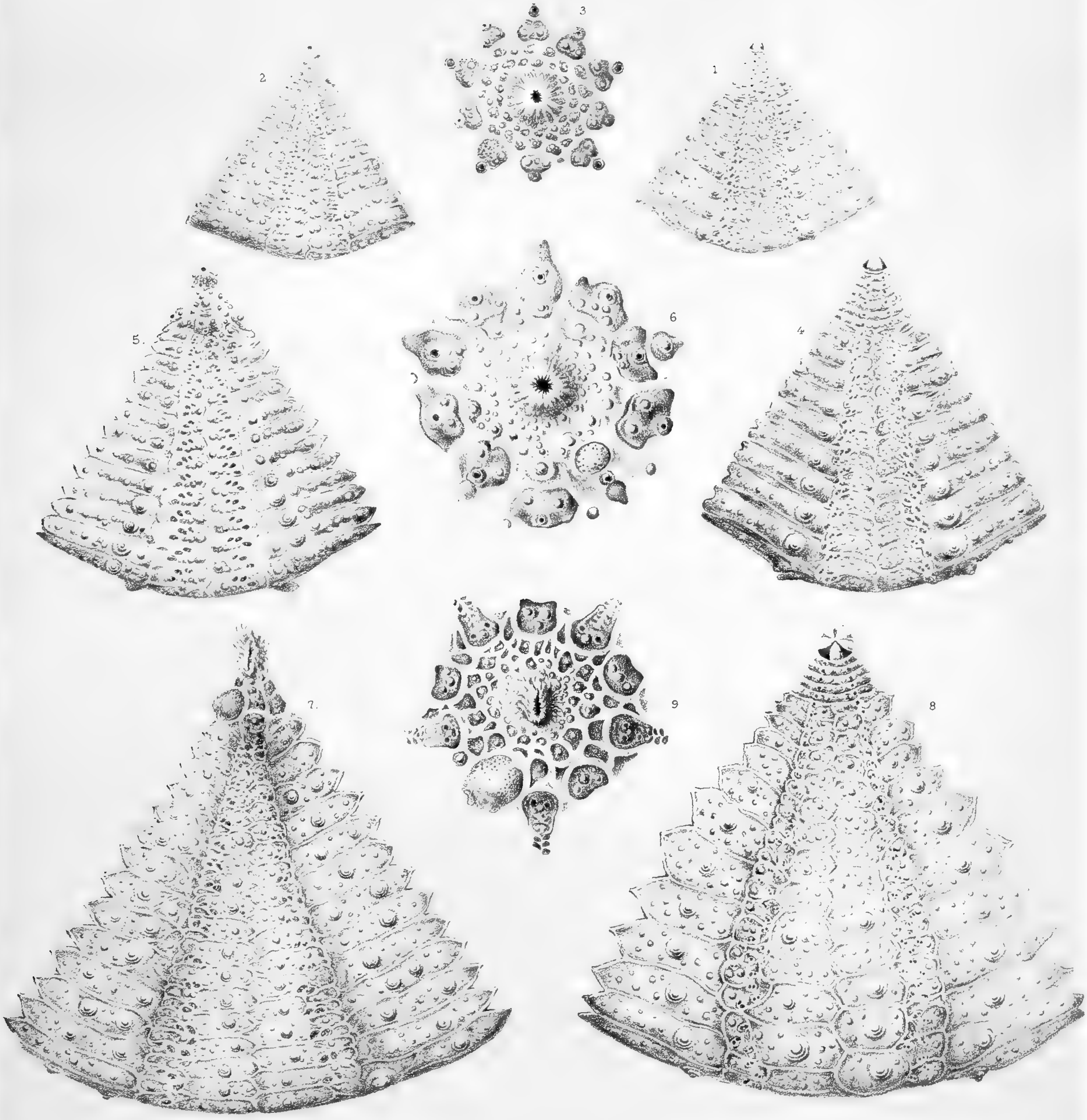


ASTHENOSOMA CRACILIS. ASTHENOSOMA CORIACEA.

8 PHORMOSOMA TENUIS



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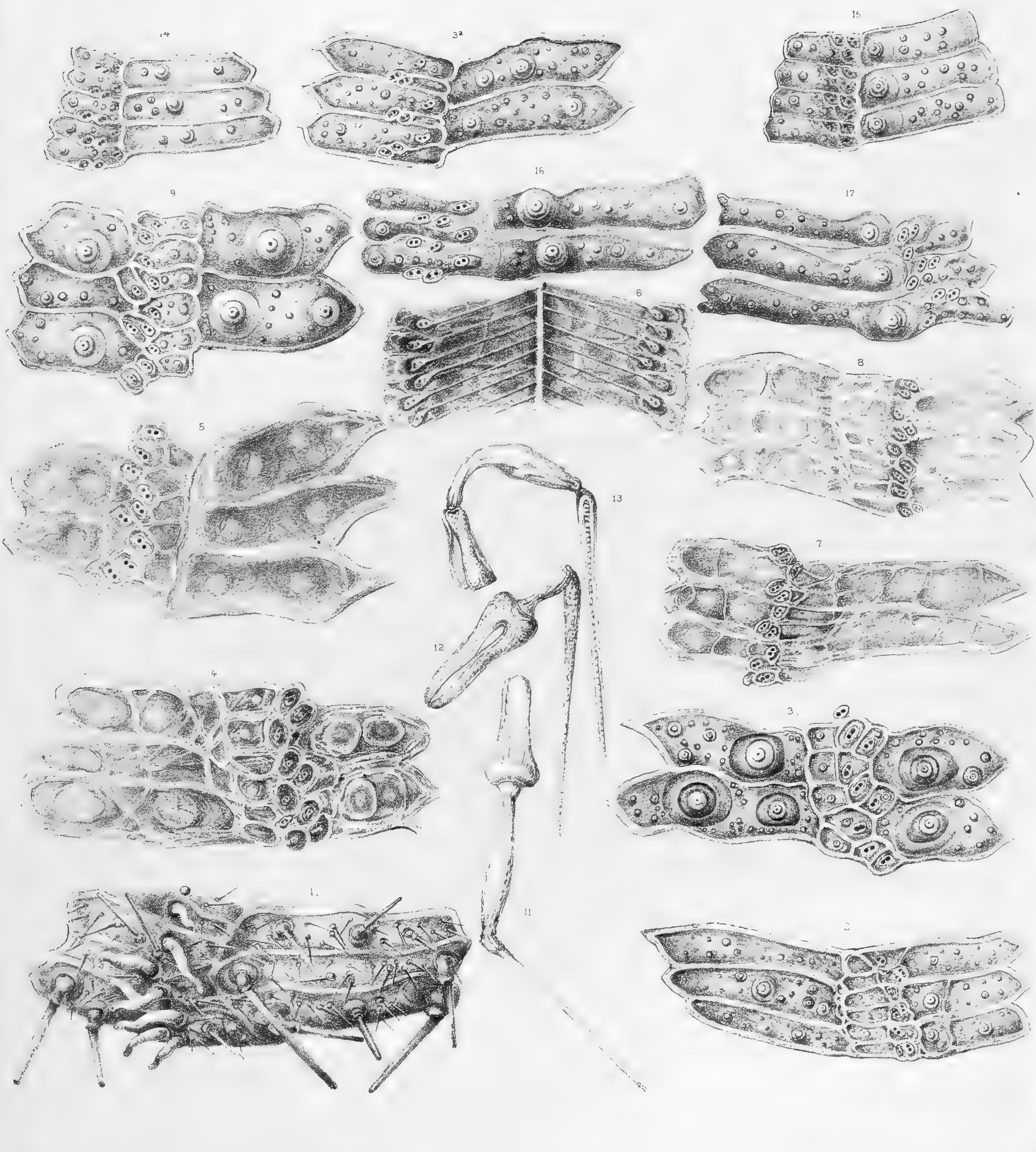

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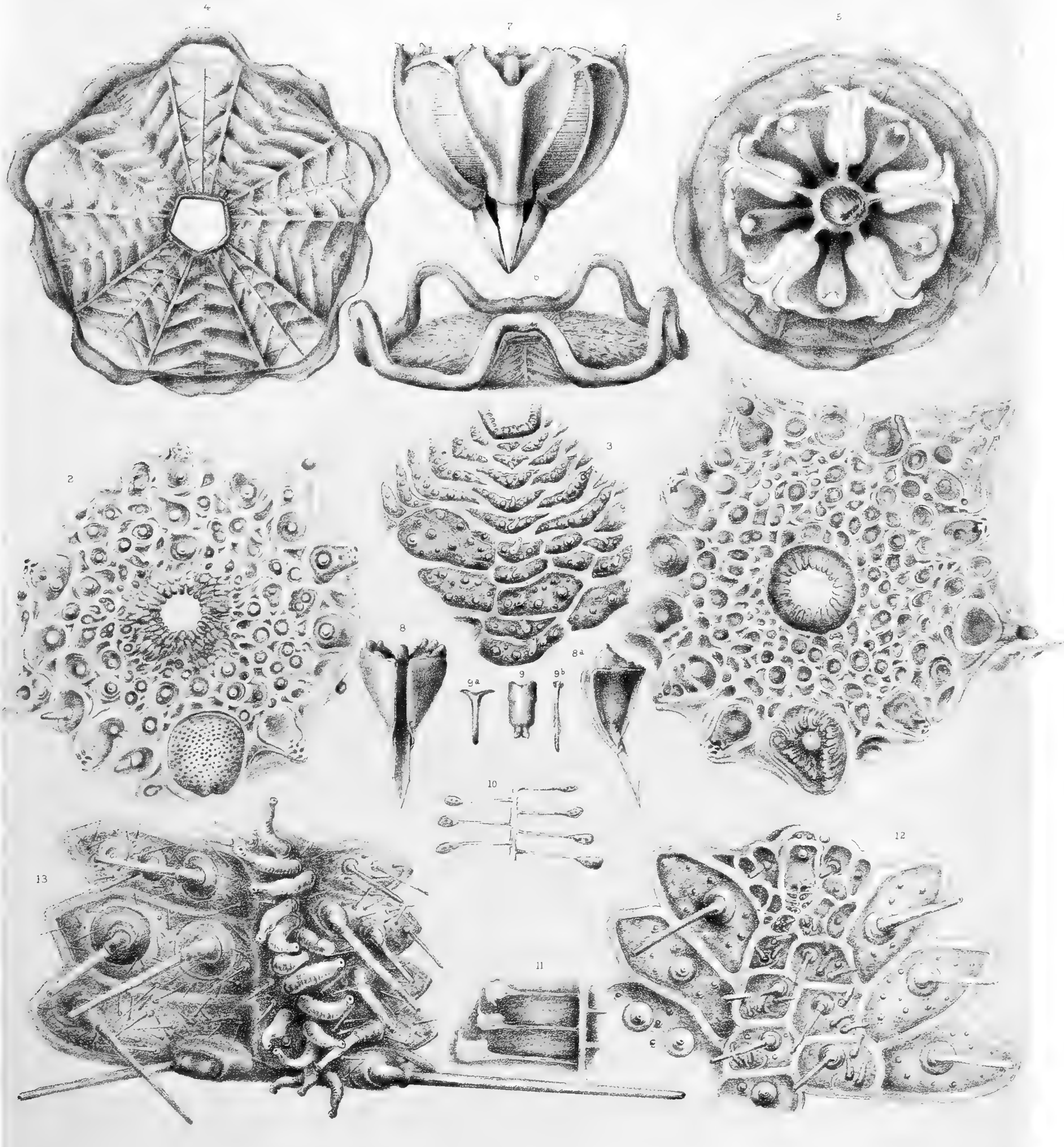

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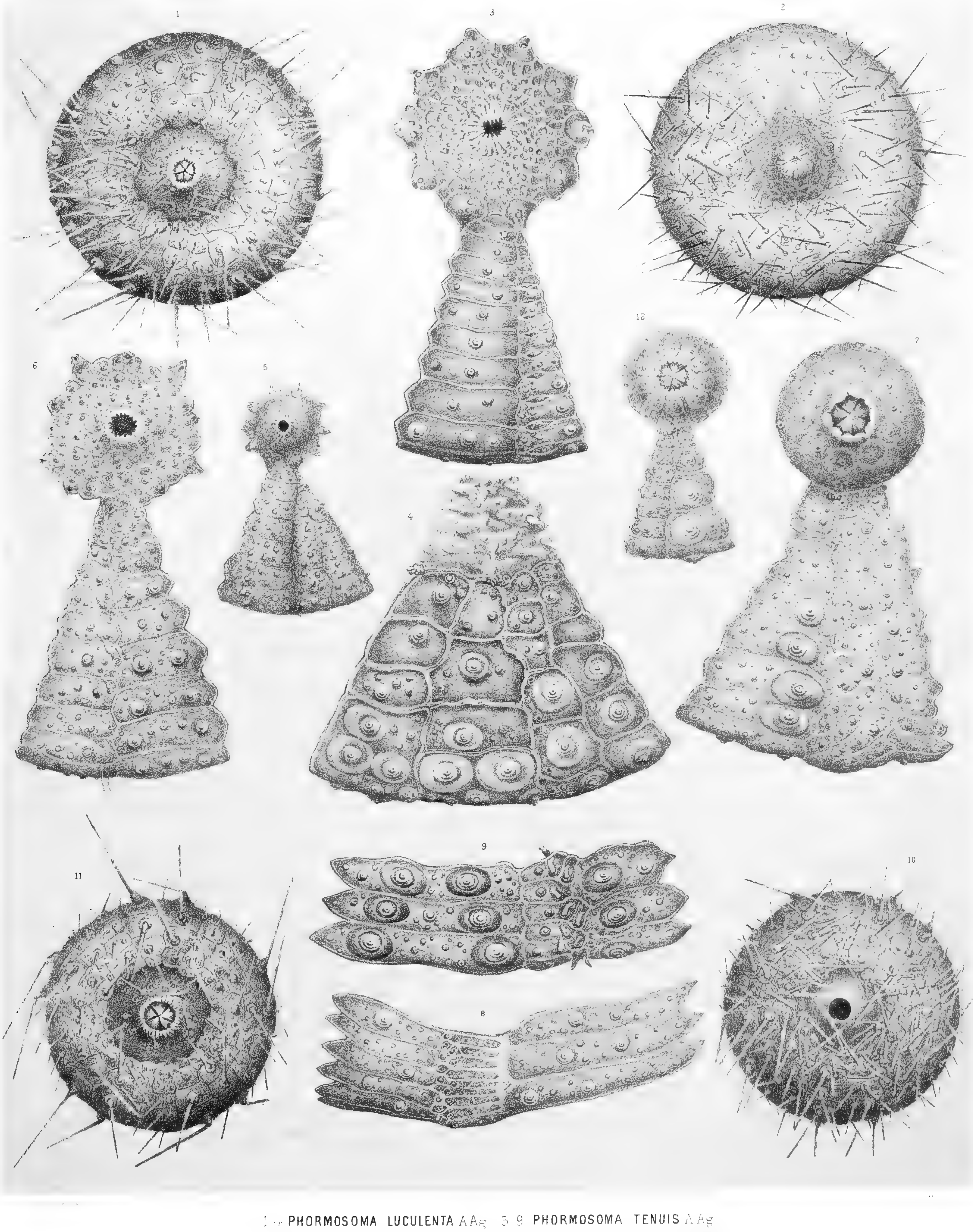
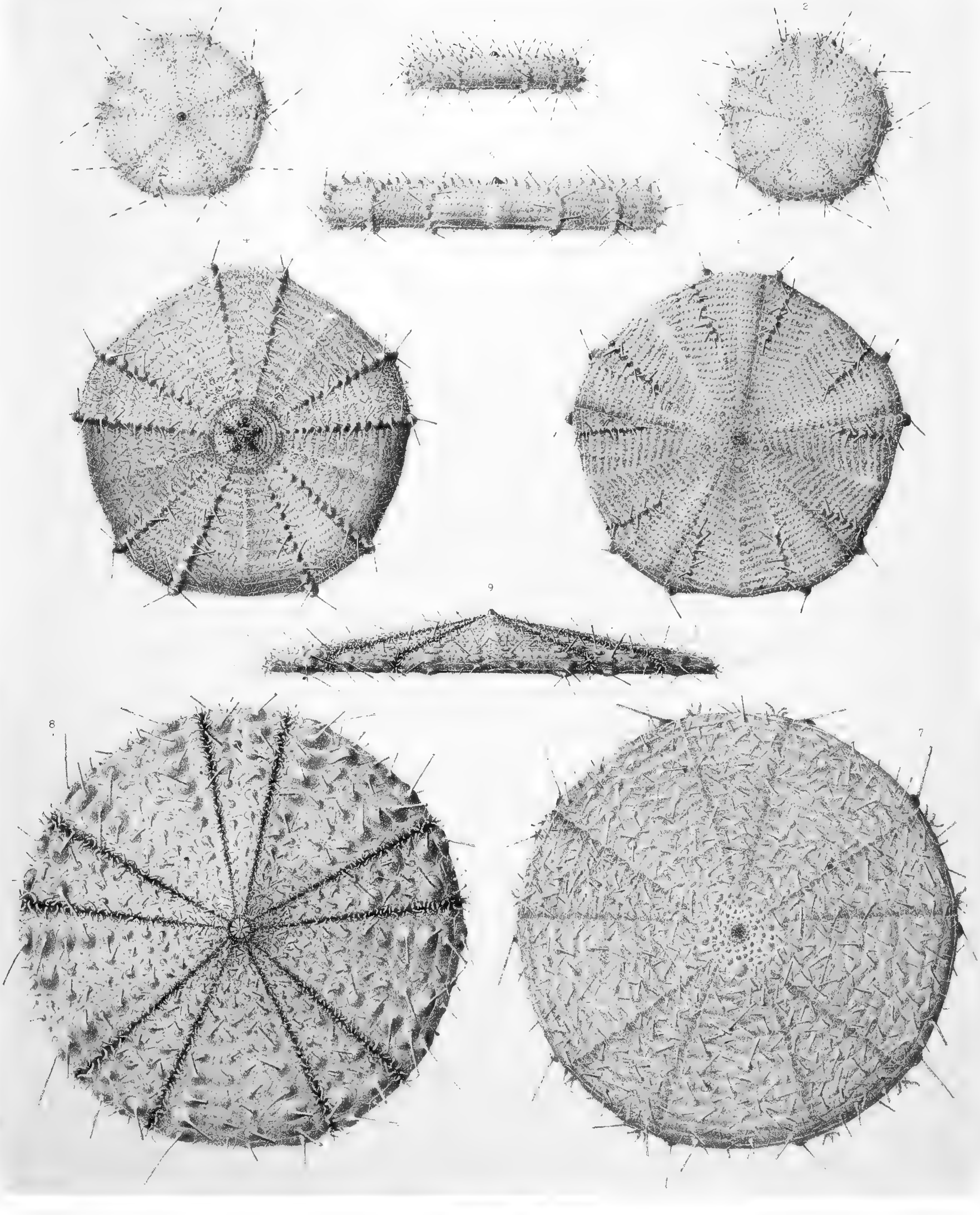


1–4 PHORMOSOMA LUCULENTA A.Ag. 5–9 PHORMOSOMA TENUIS A.Ag.
10–11 MICROPYGA TUBERCULATA. A.Ag. 12 PHORMOSOMA URANUS Wyv.Thor.



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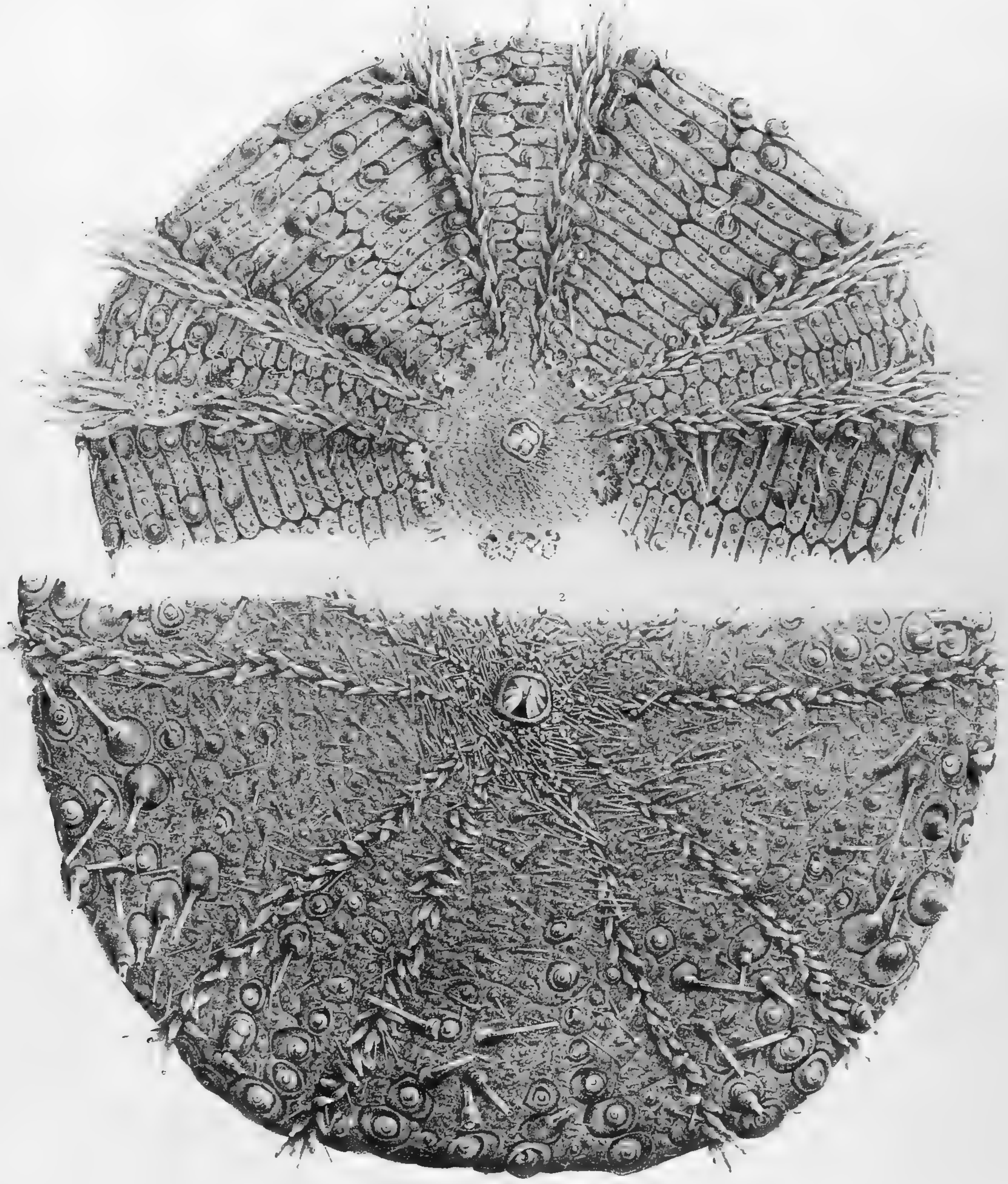
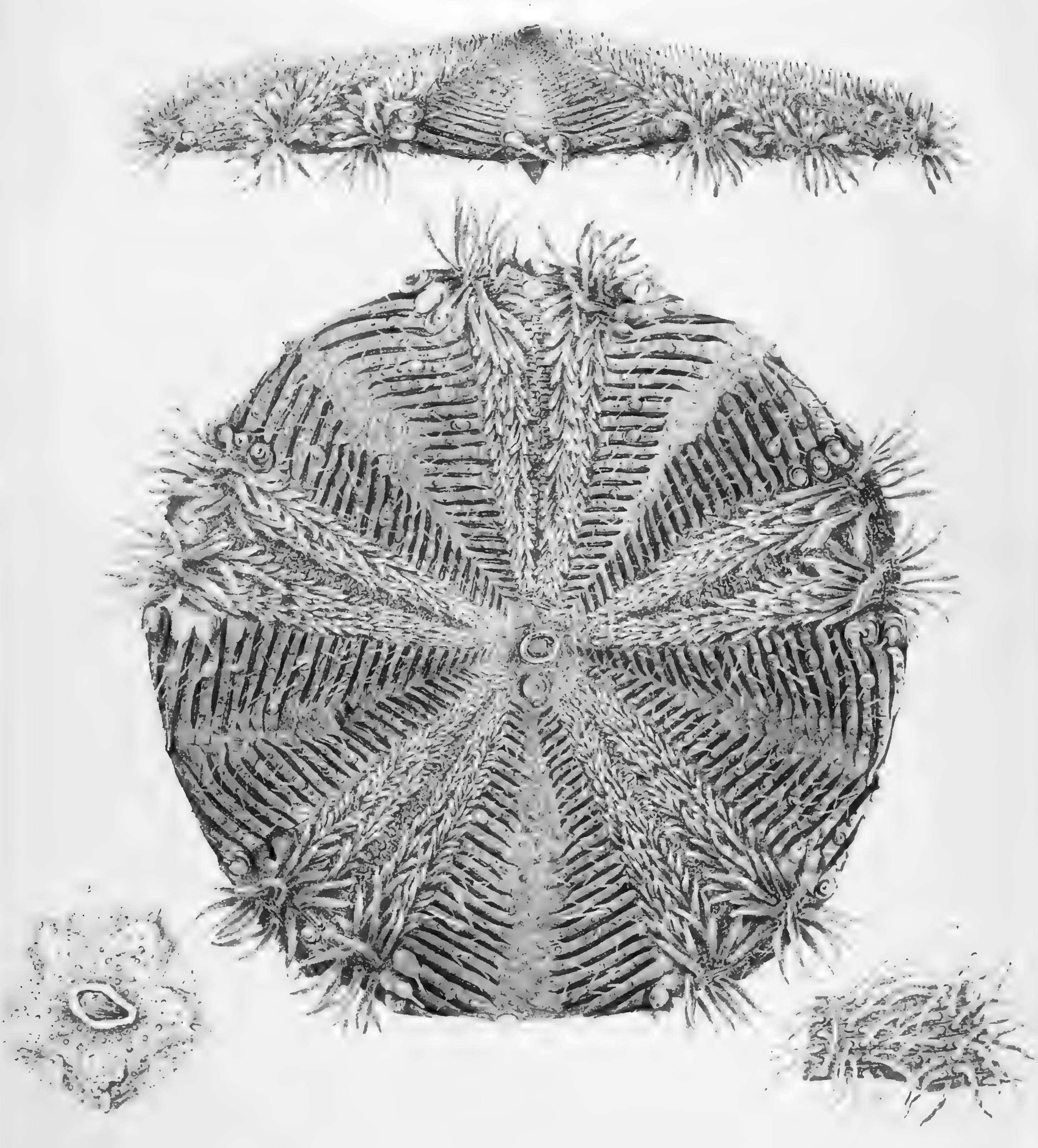


1 ASTHENOSOMA TESSELLATA · 2 PHORMOSOMA TENUIS



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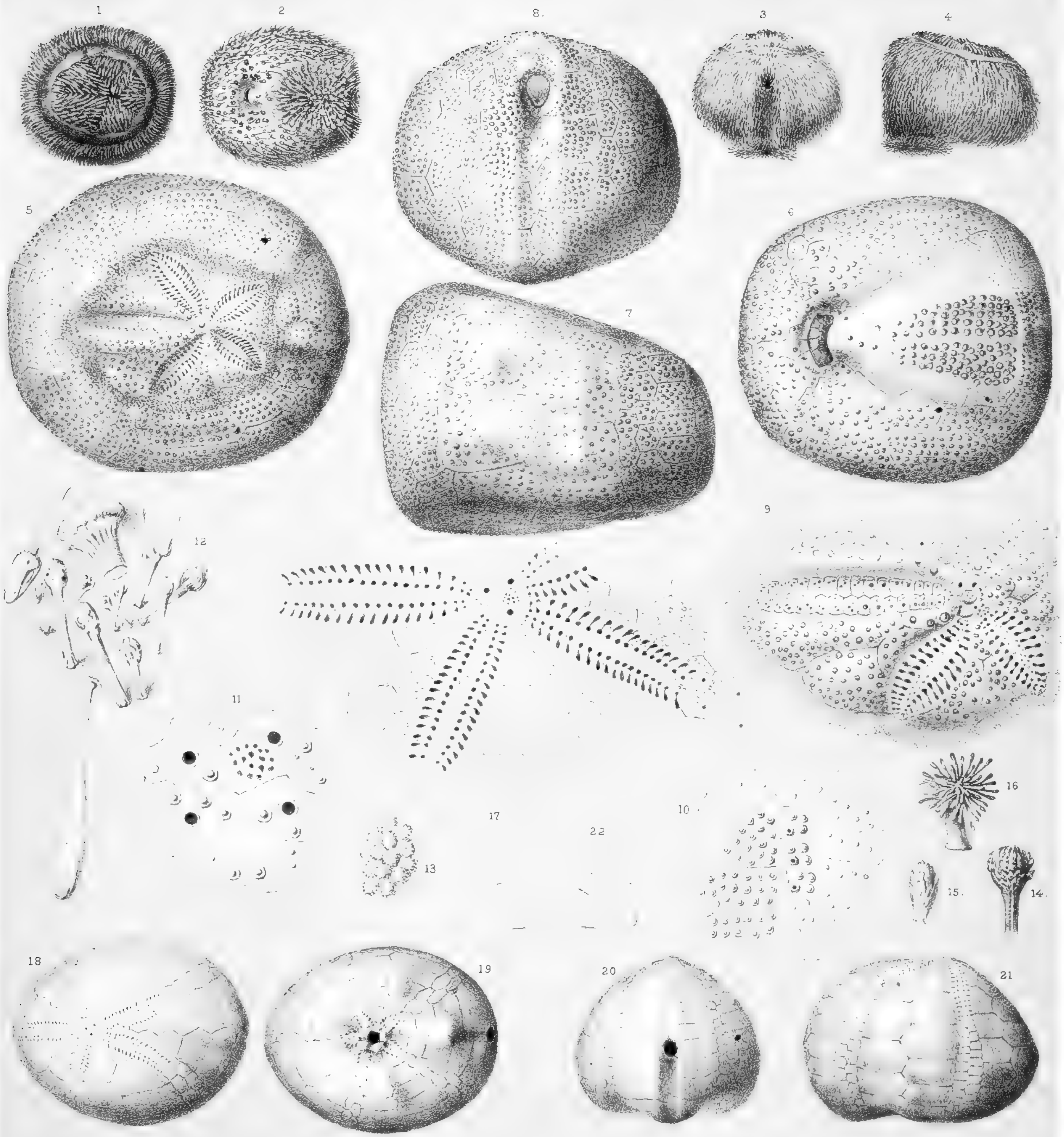

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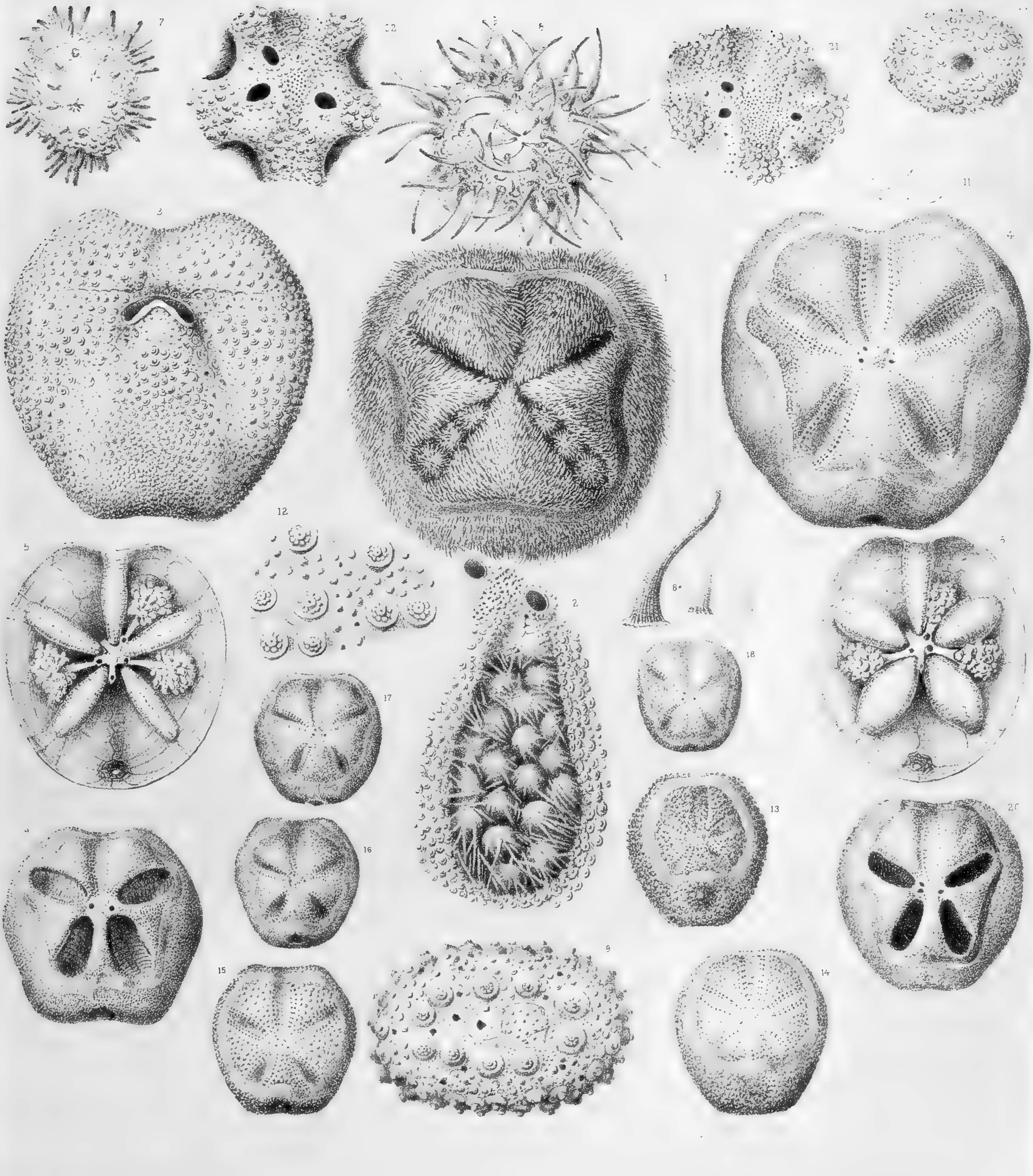
17–22. CATOPYGUS RECENS. A. Ag.



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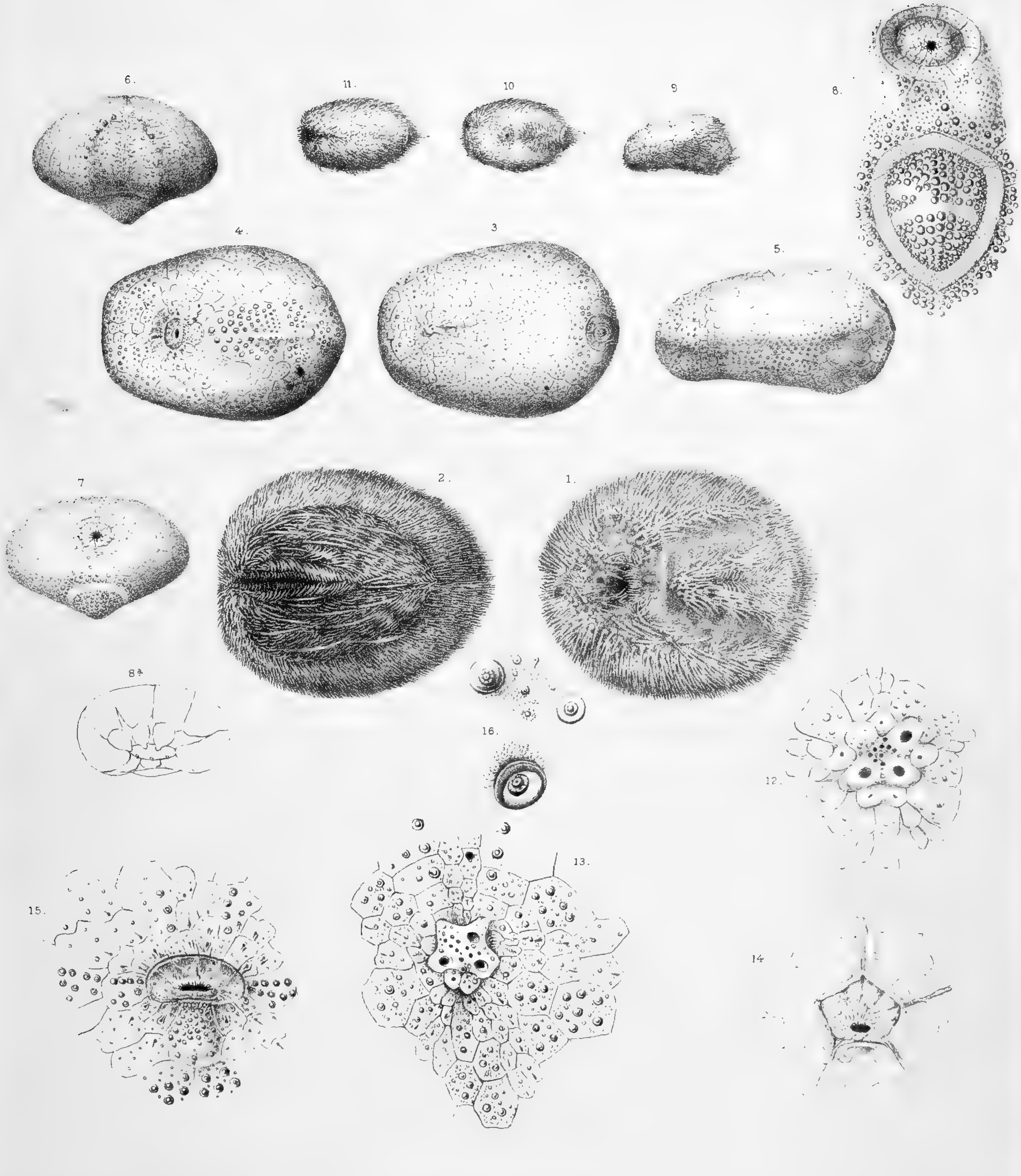

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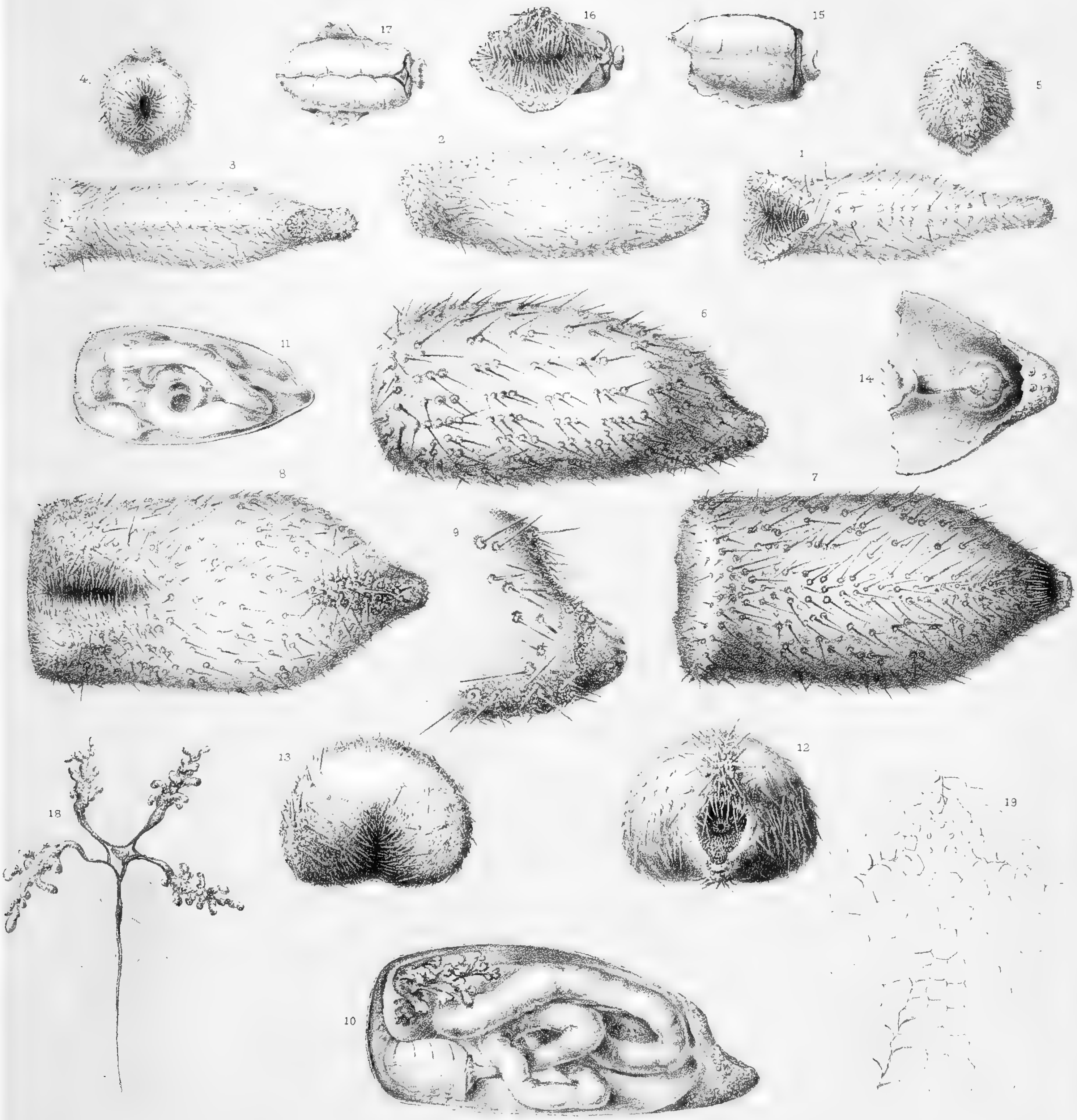

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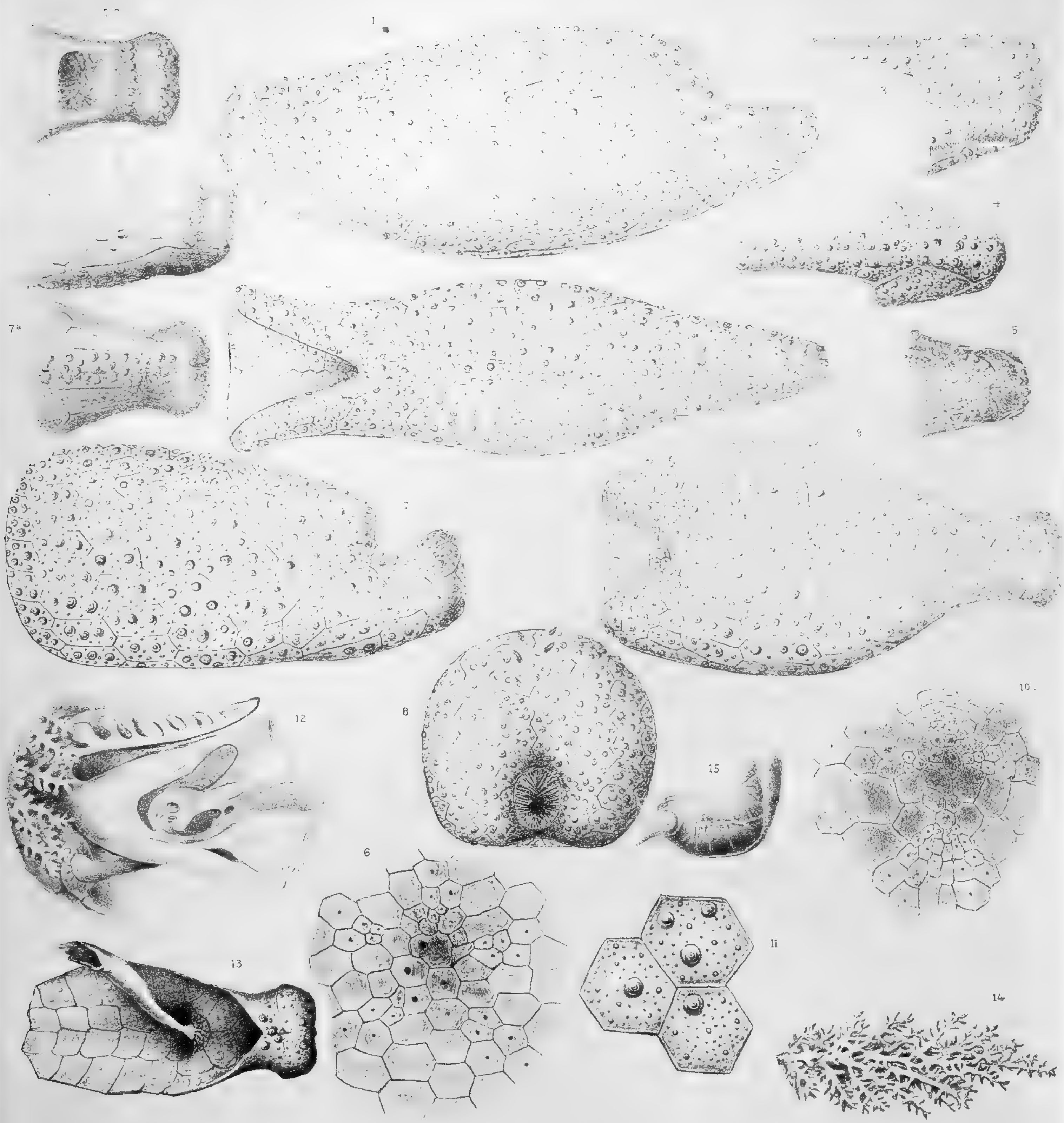

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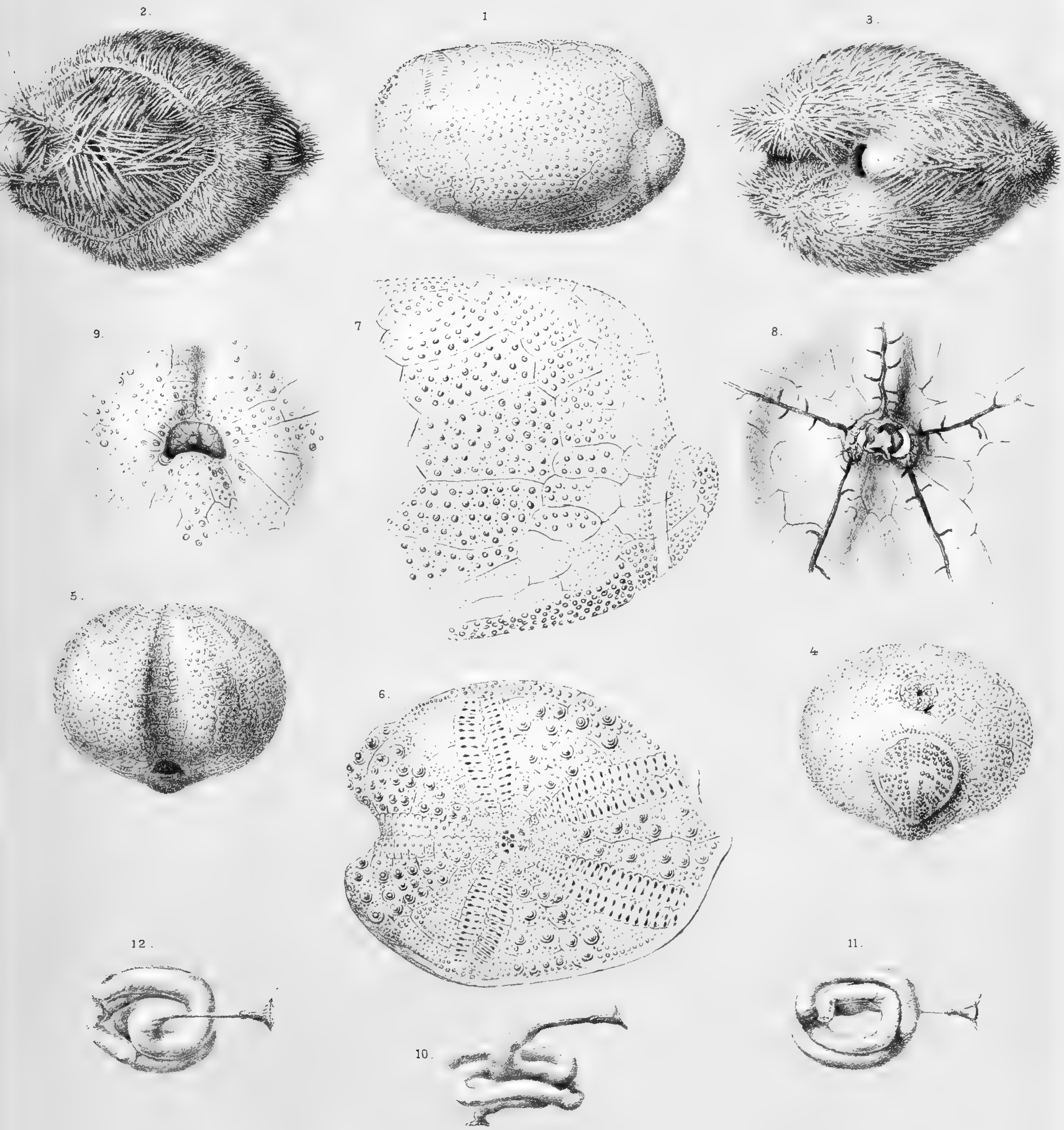

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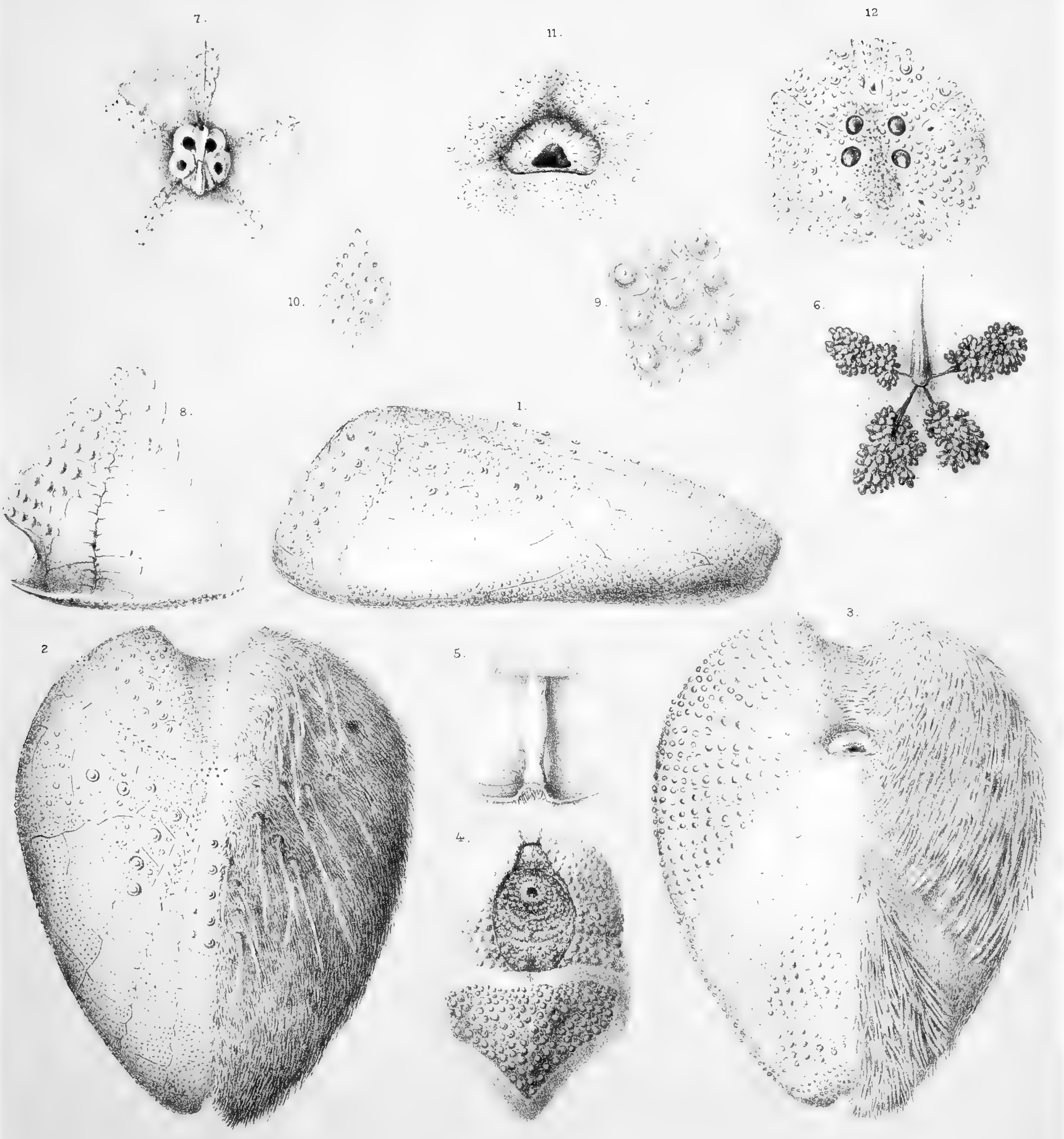

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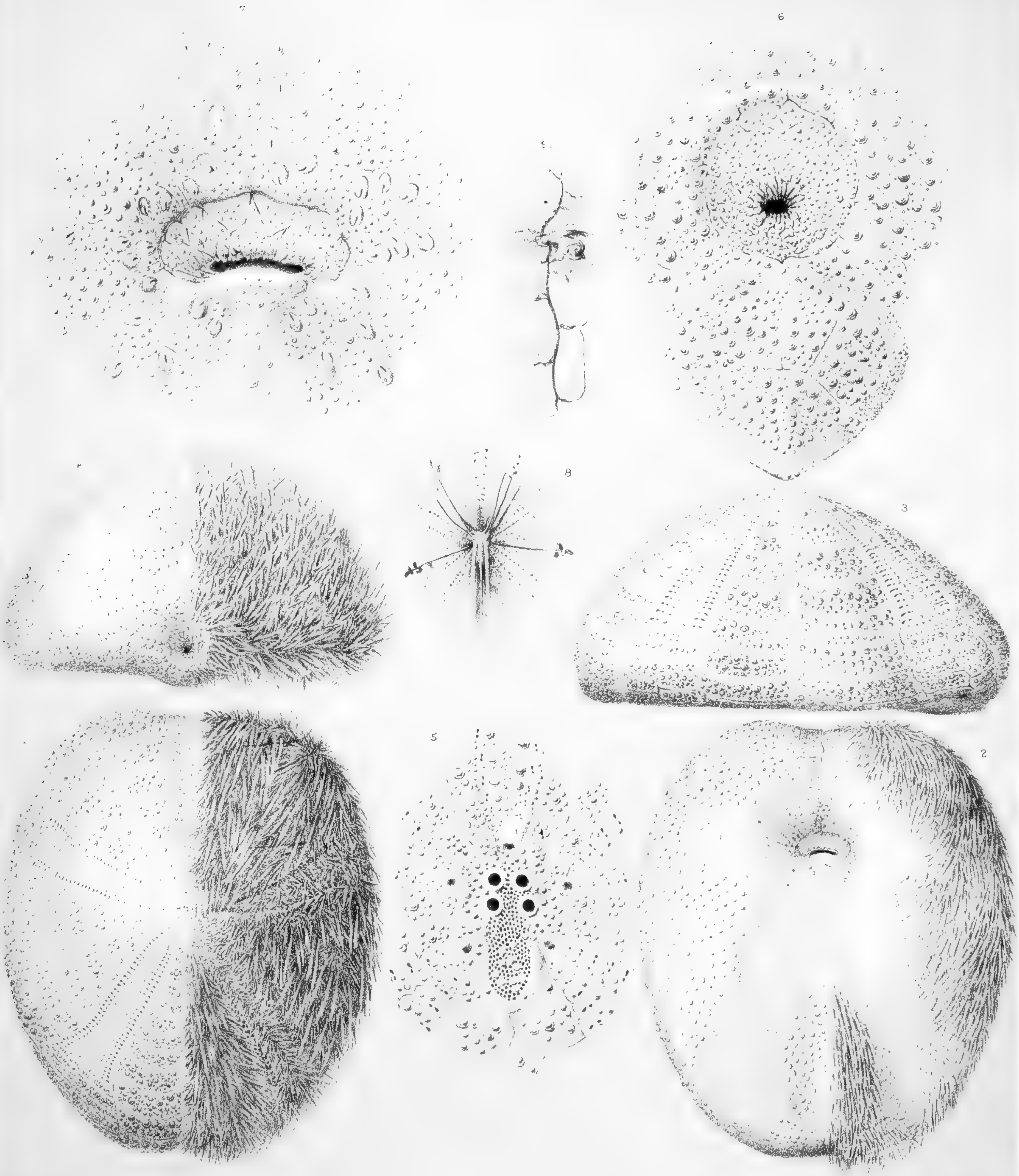

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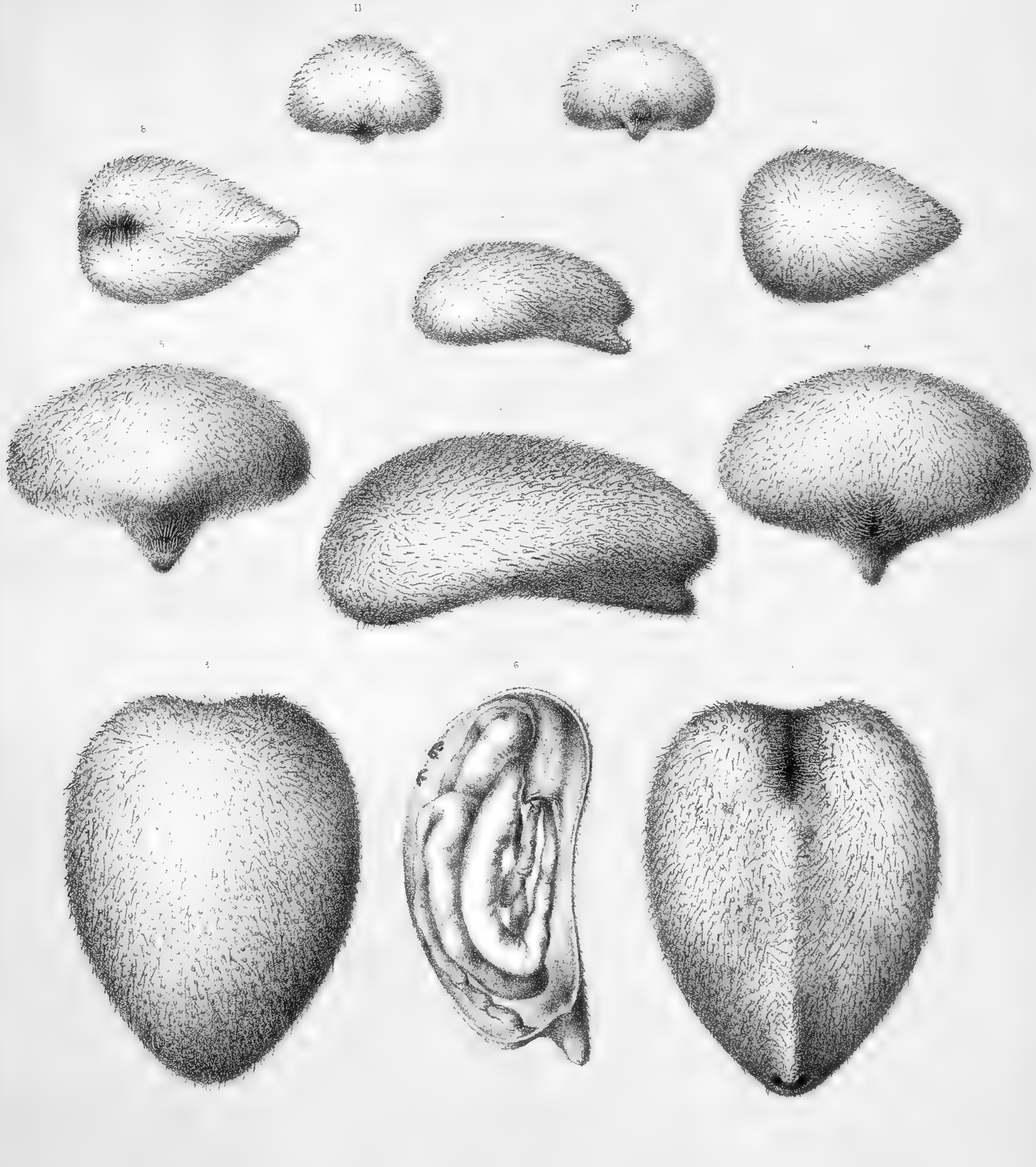

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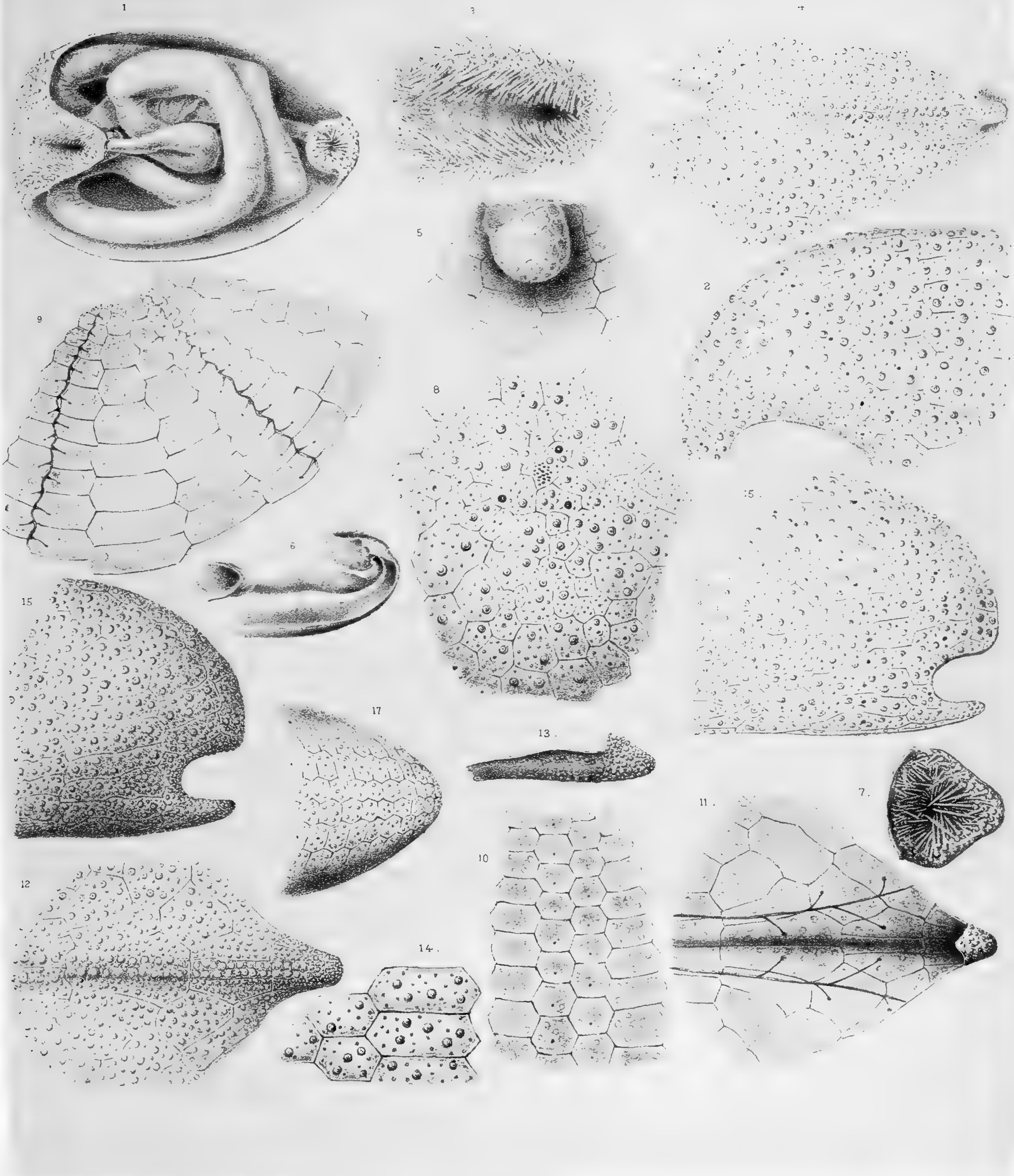

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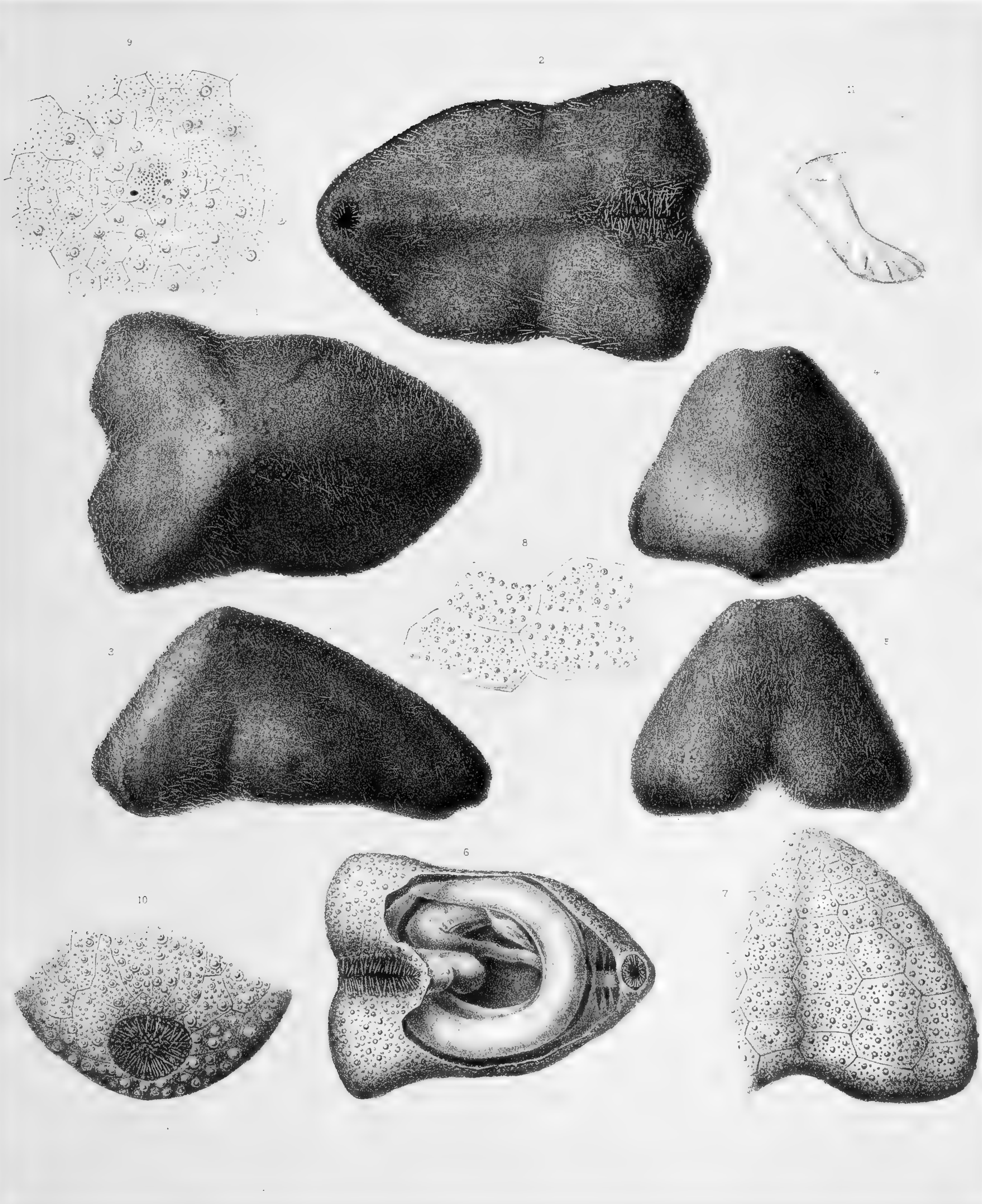

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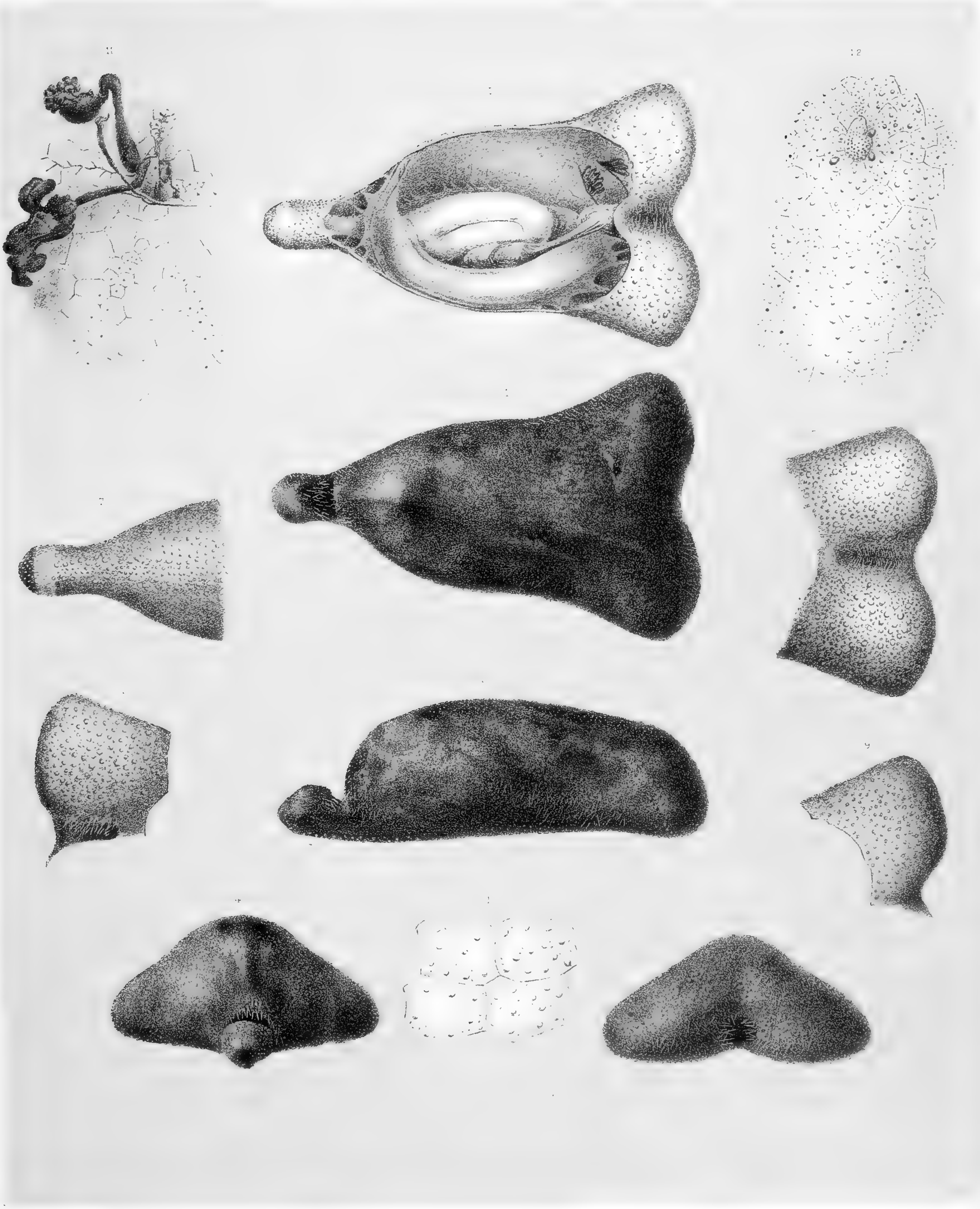

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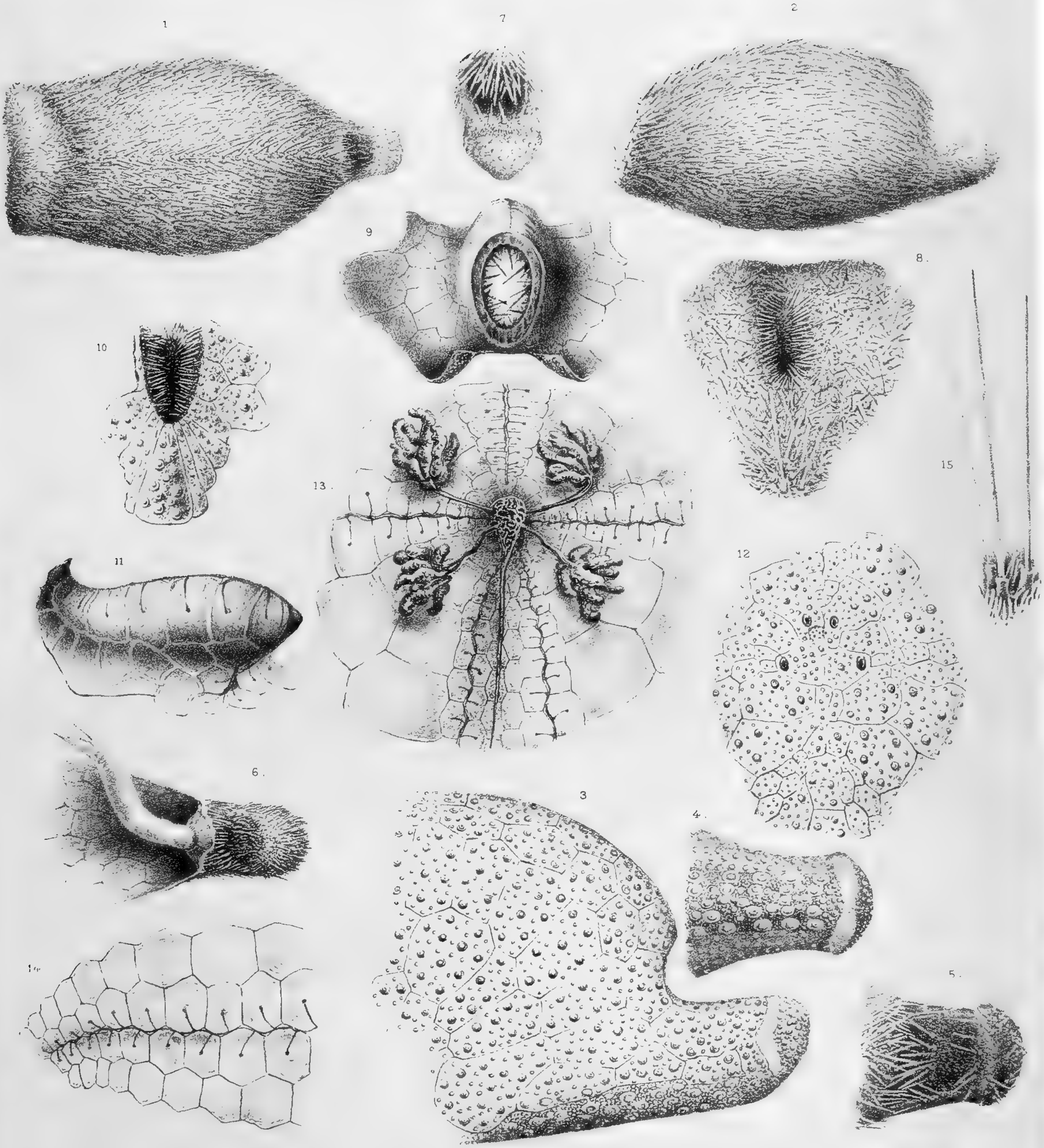

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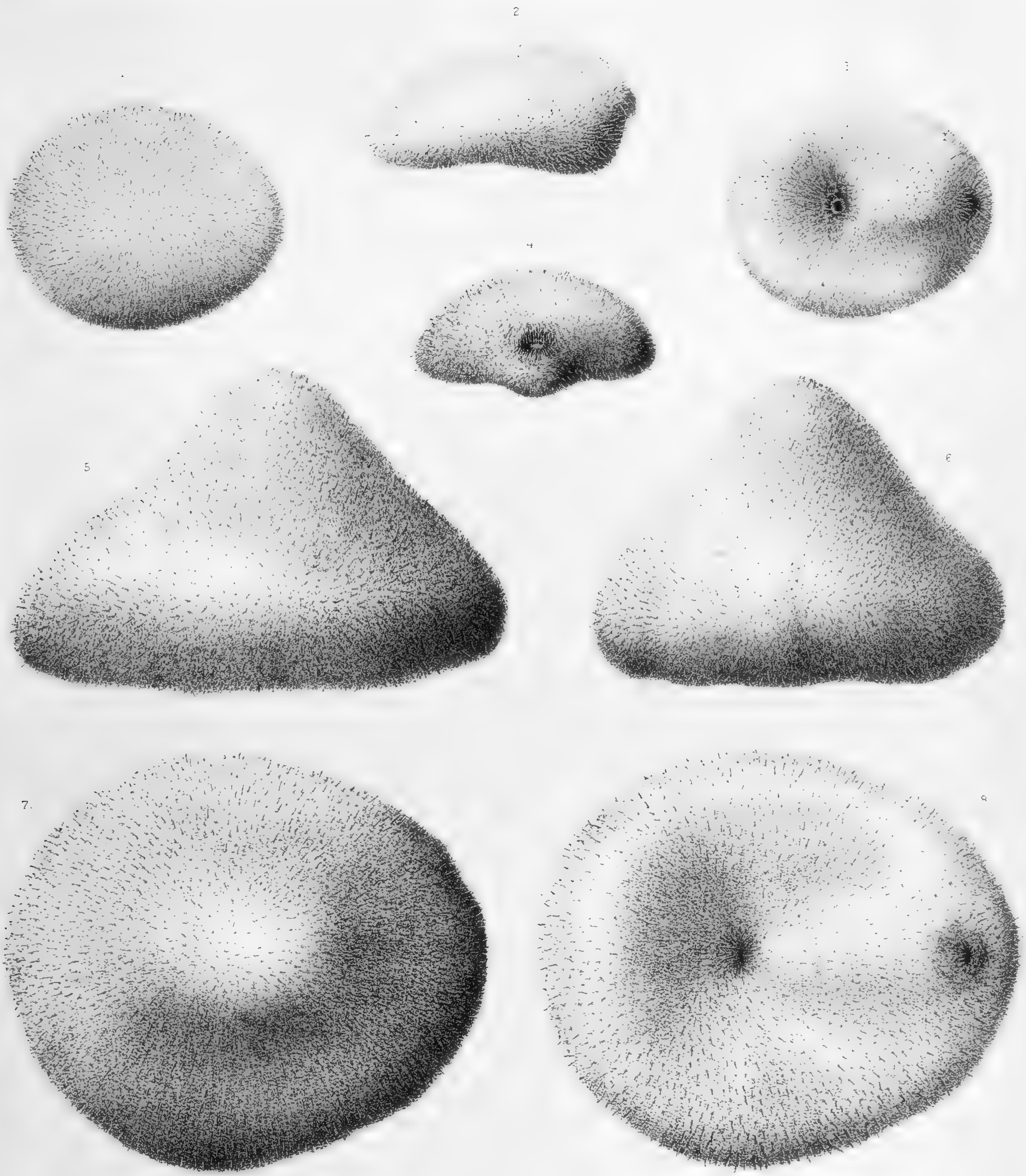

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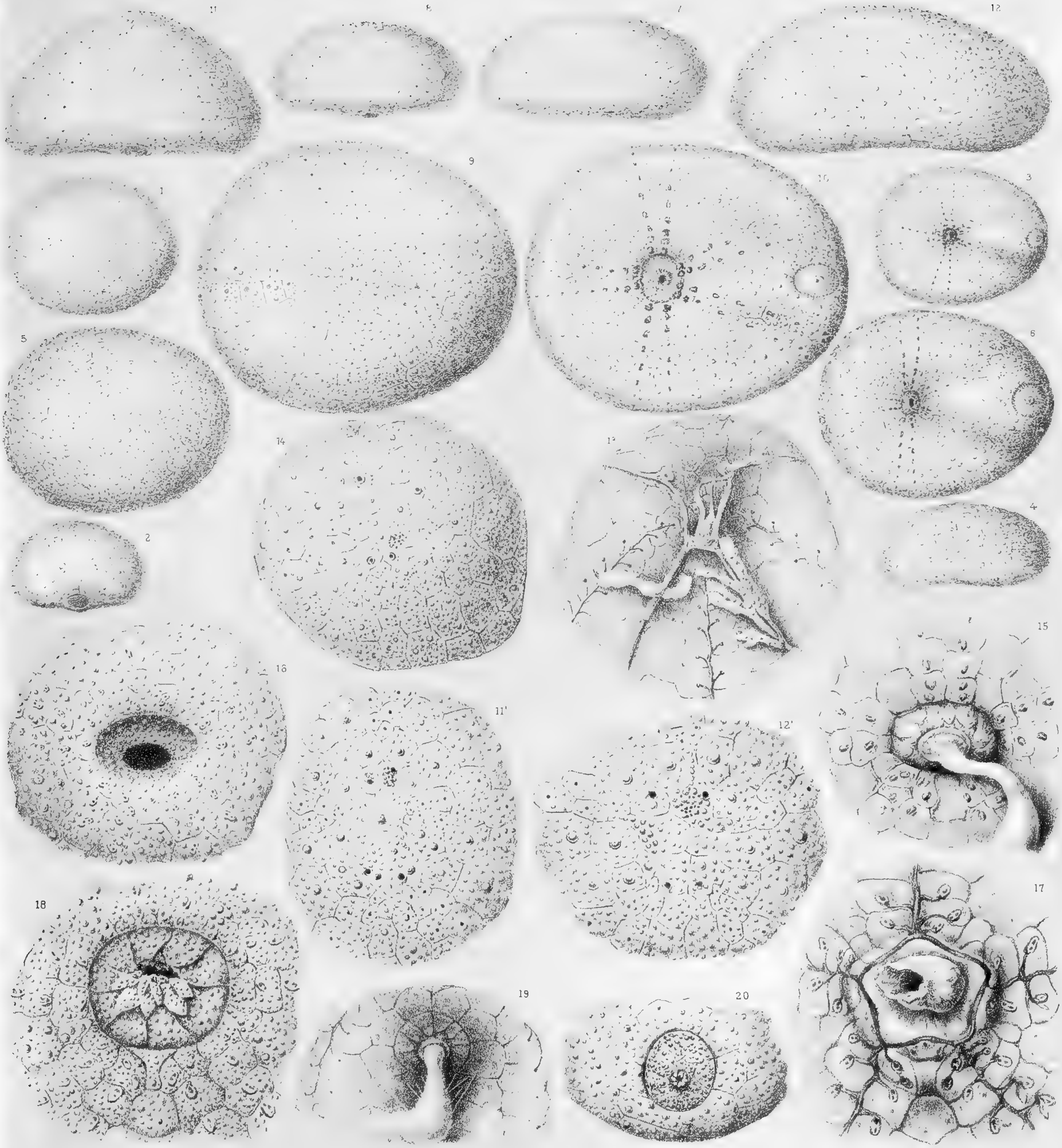

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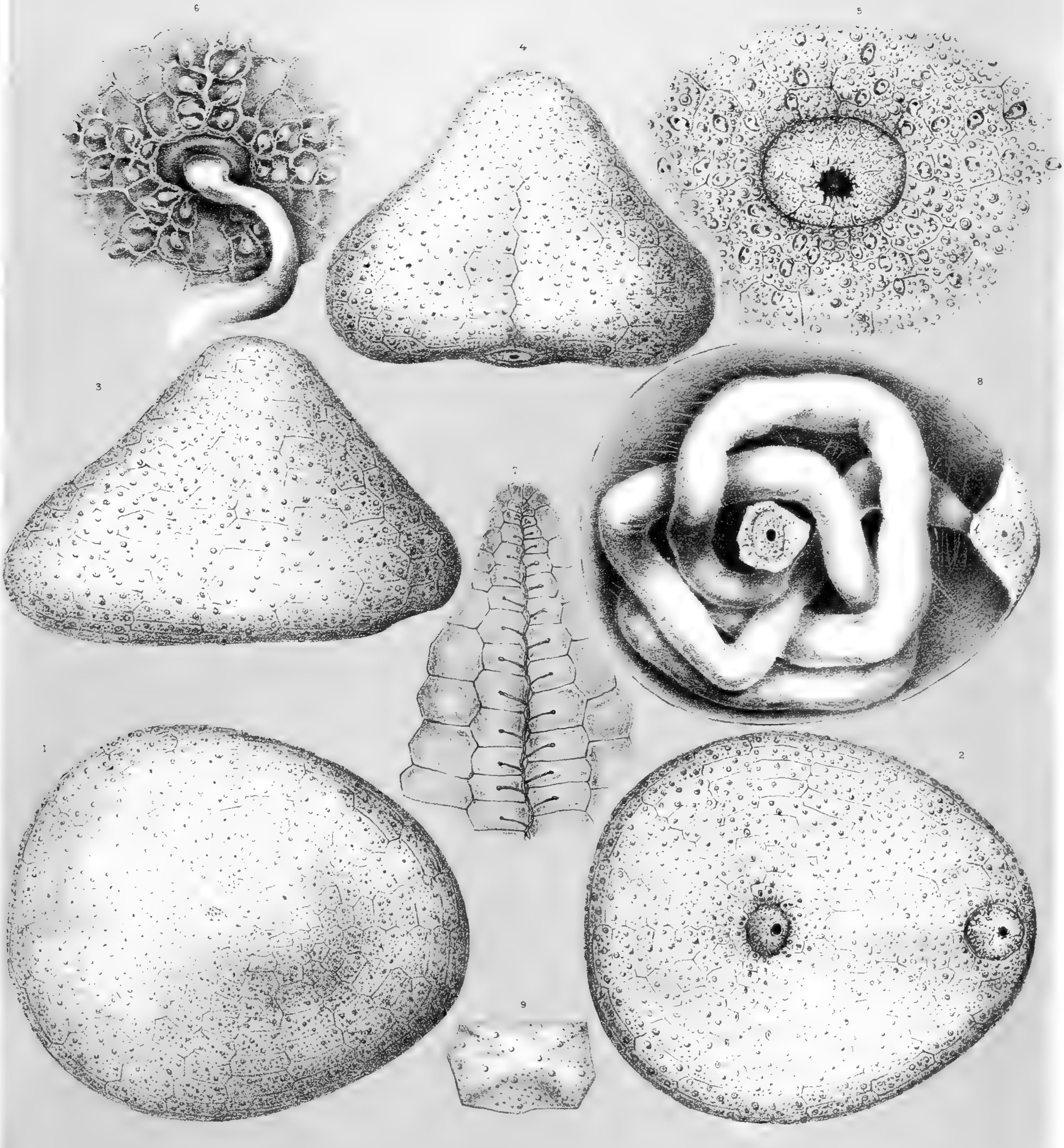

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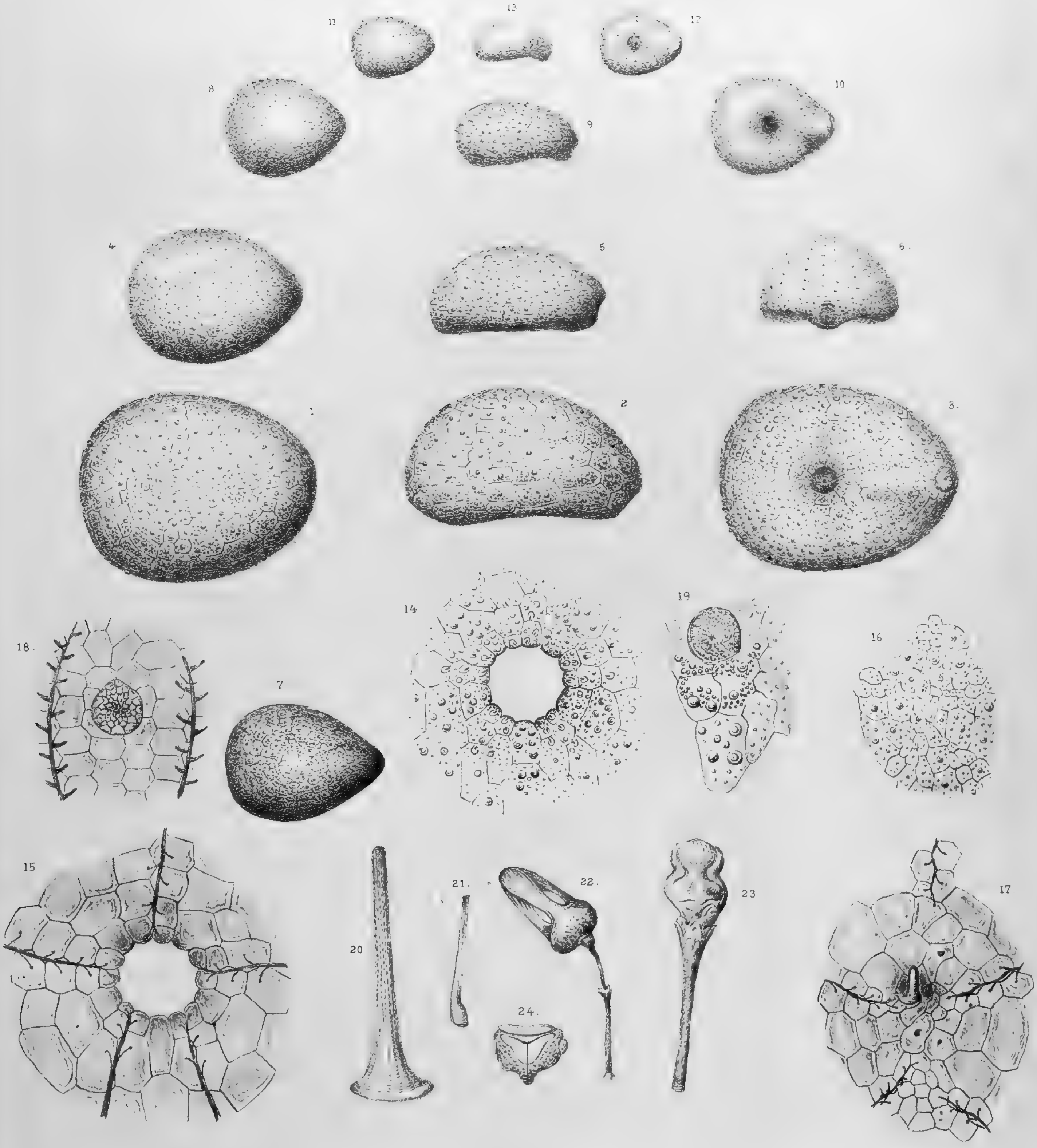

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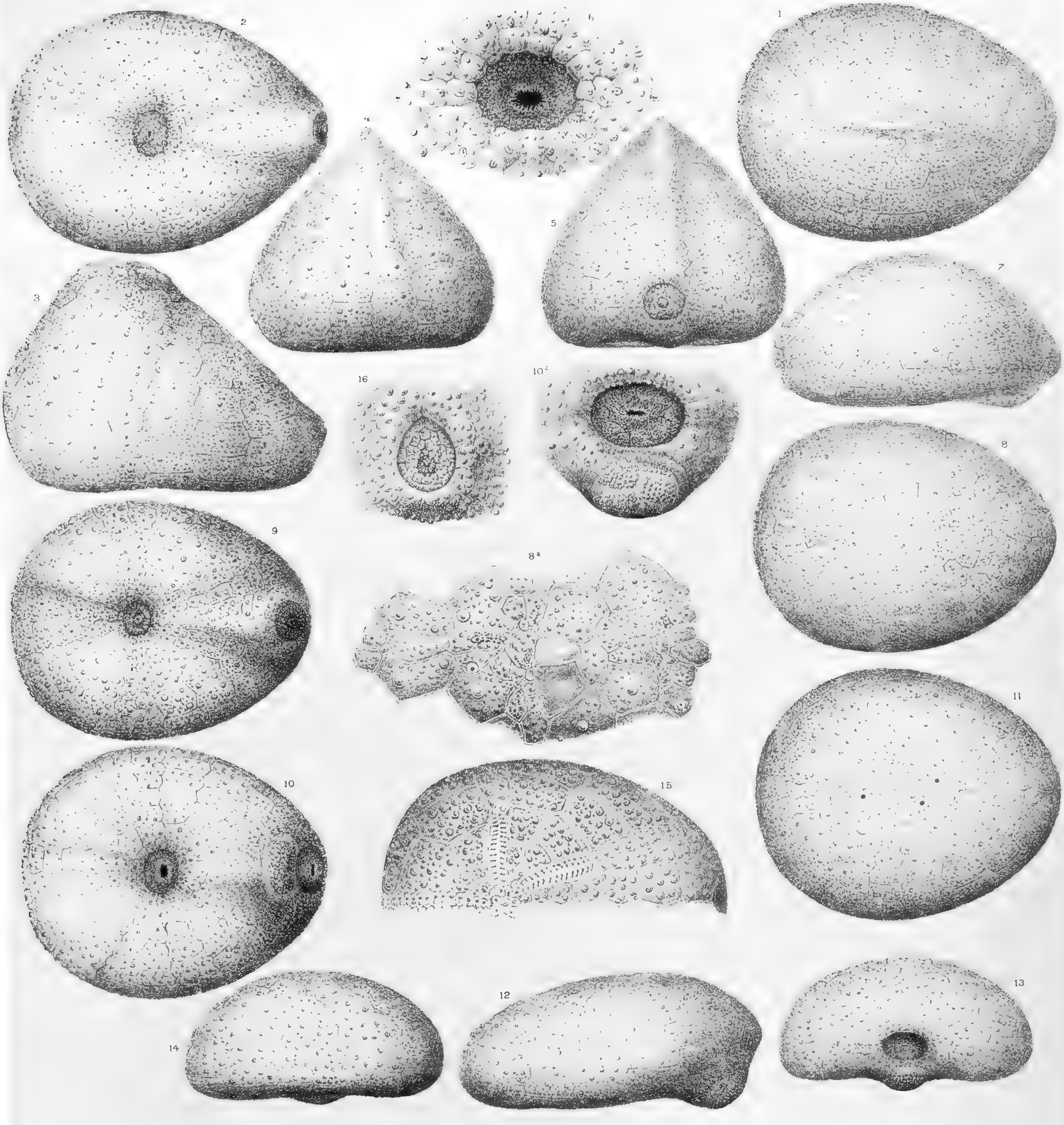

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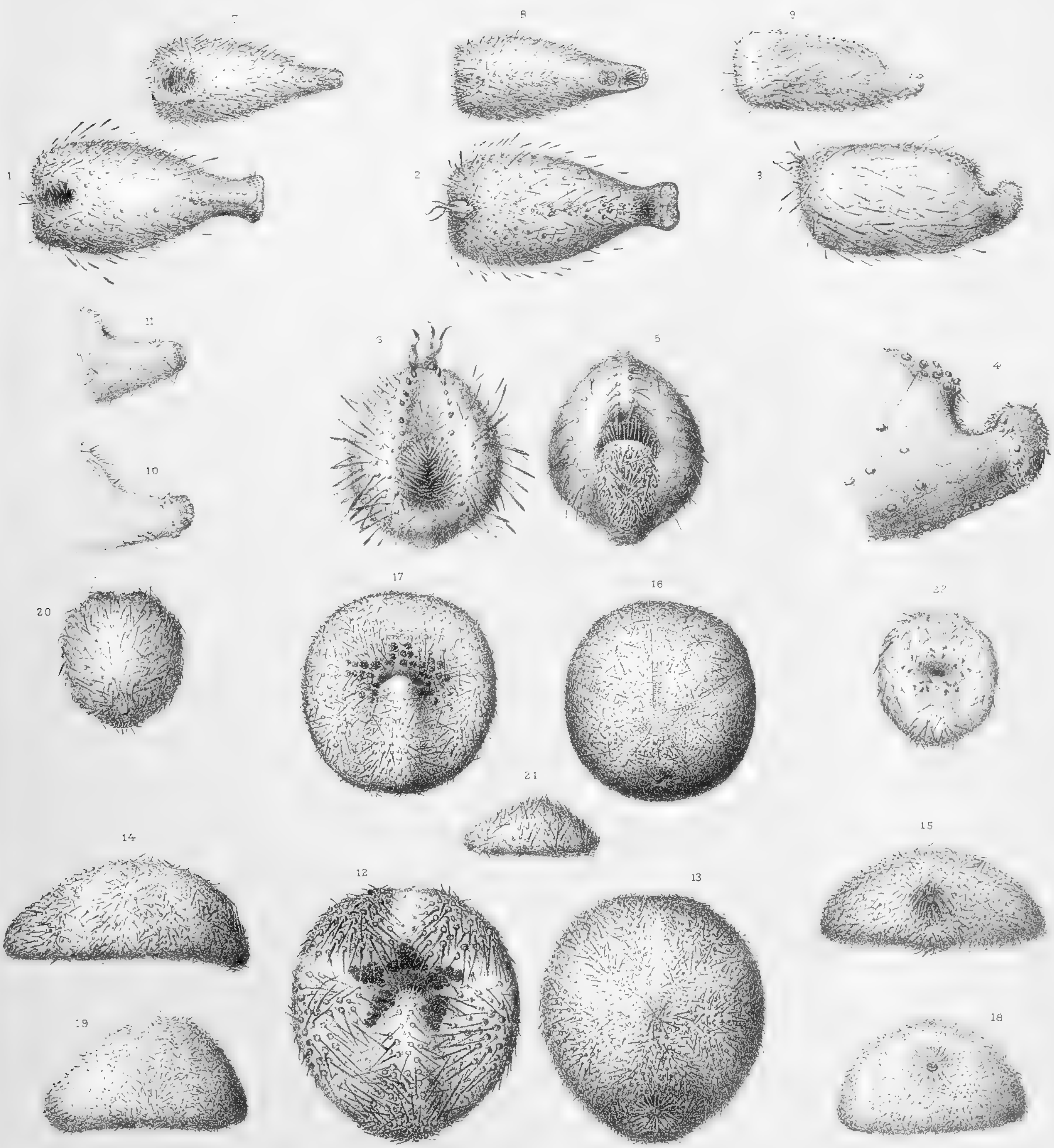

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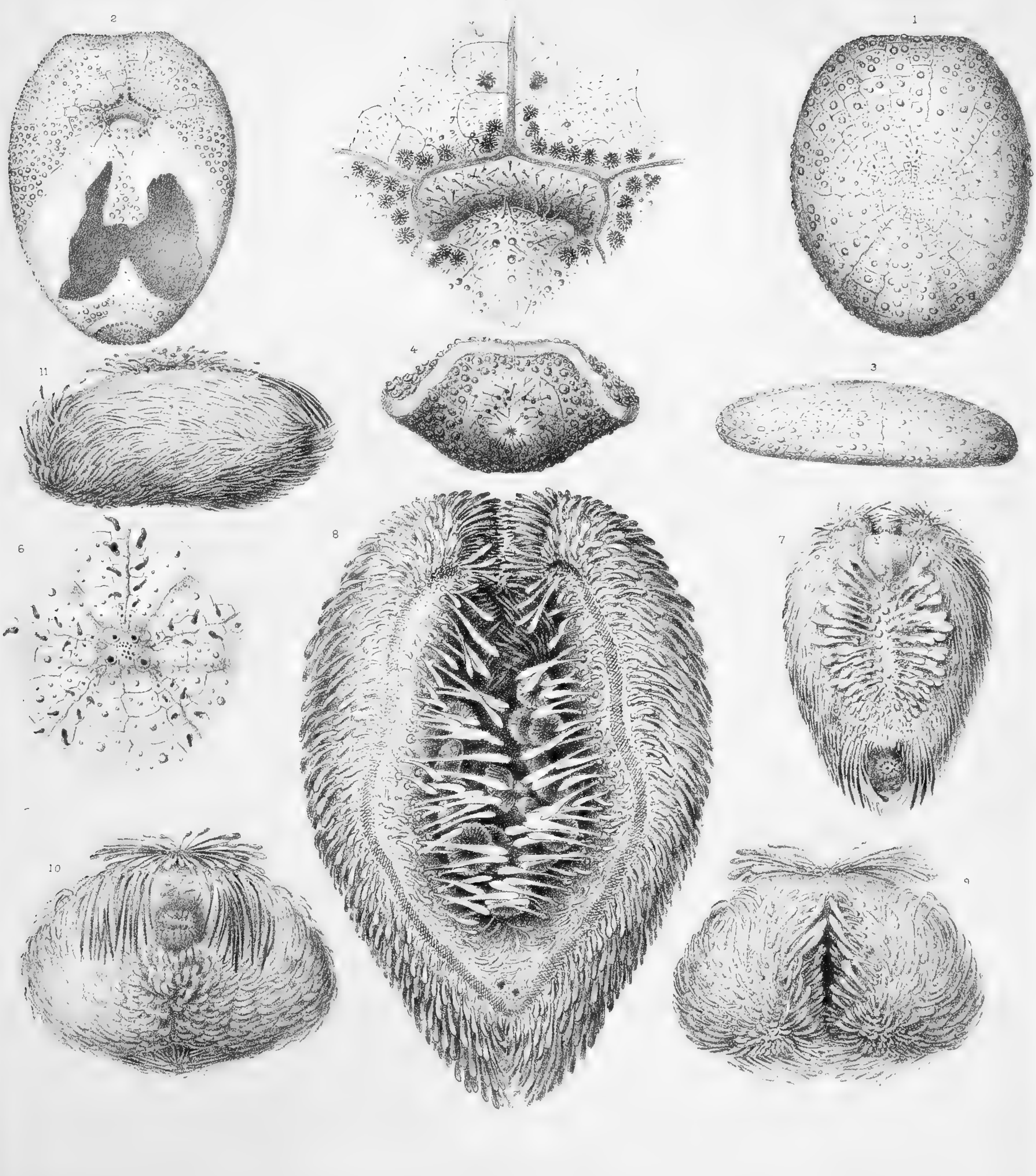

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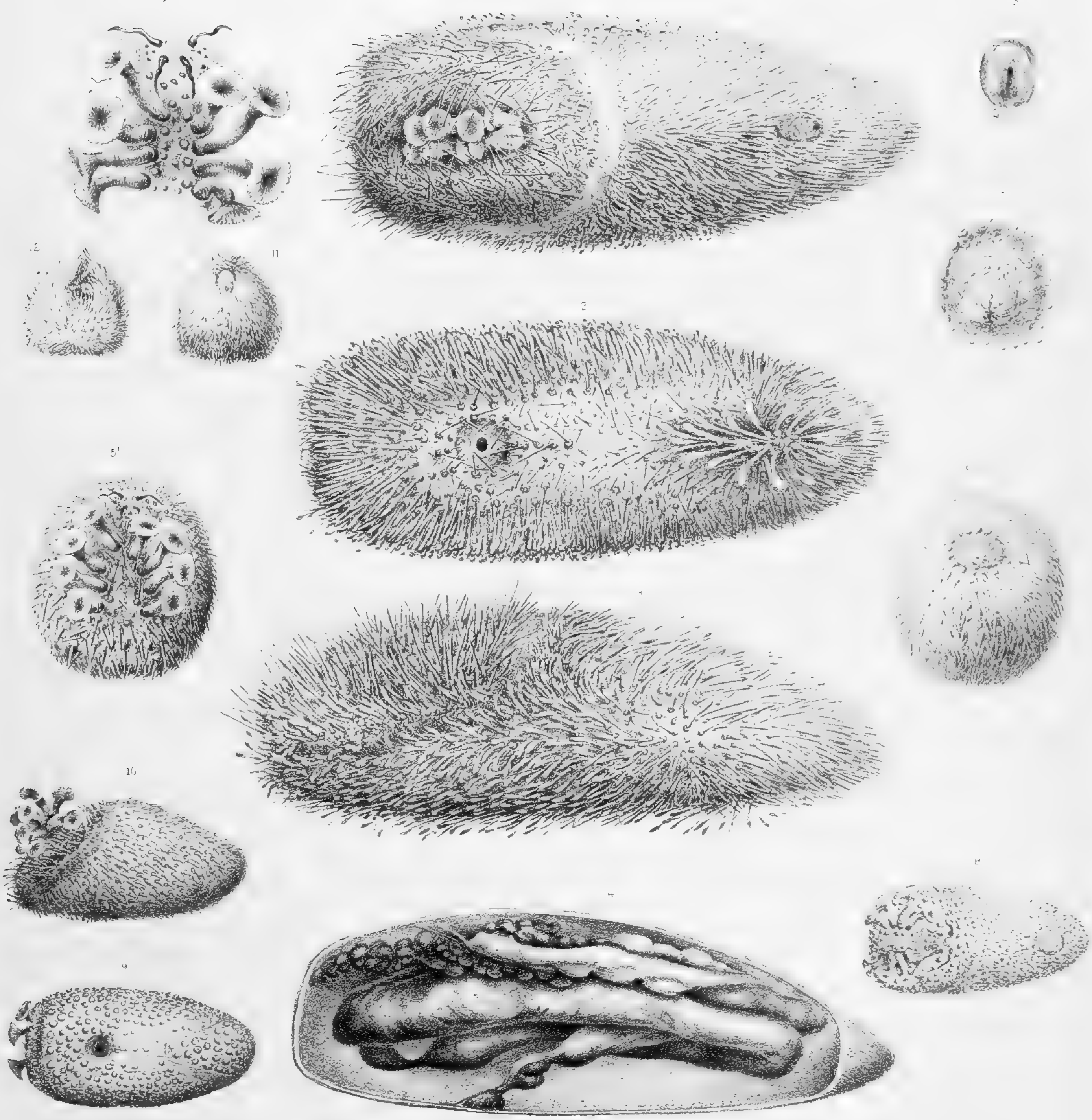
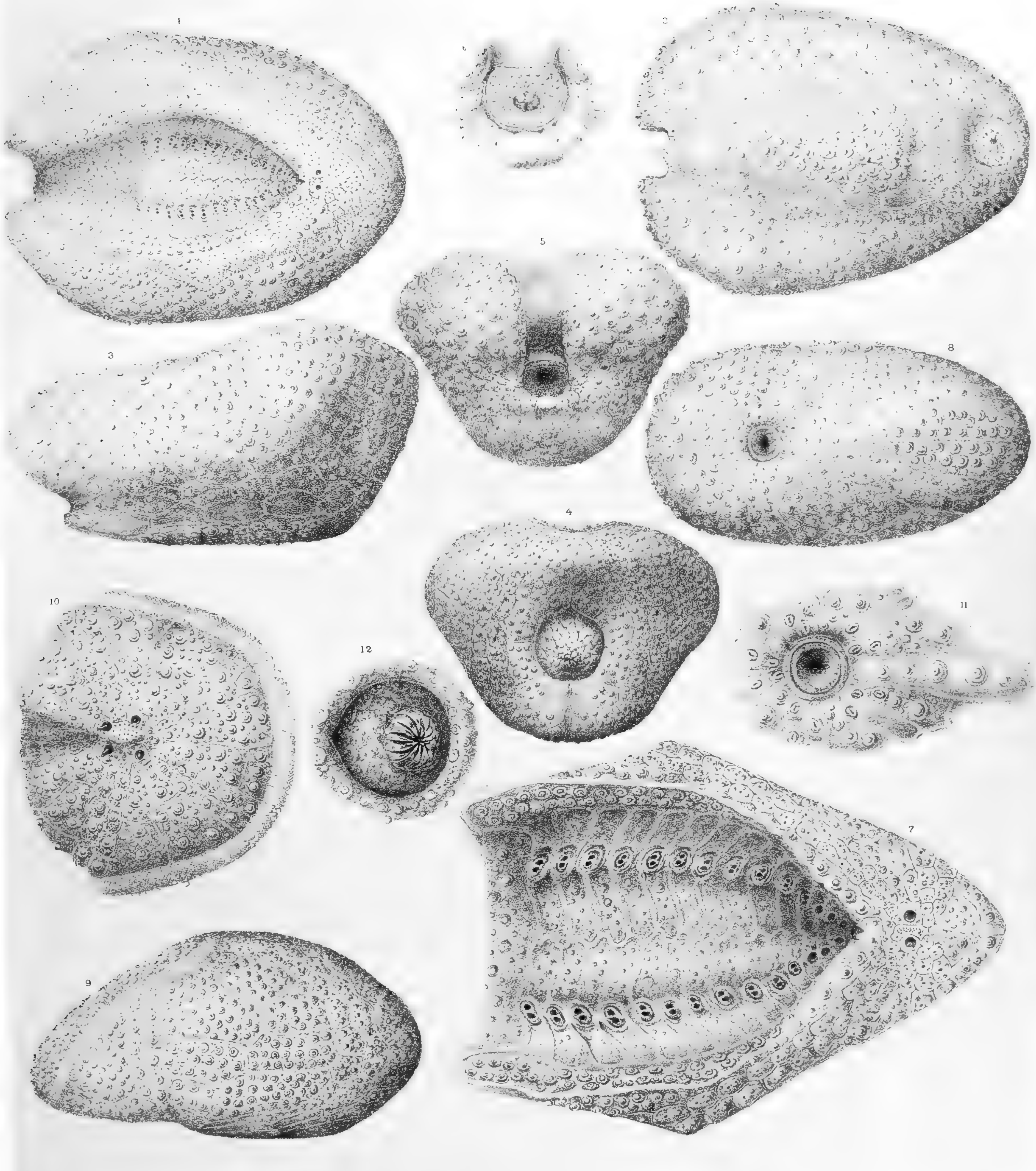


AEROPE ROSTRATA *Wyv. Thom.*



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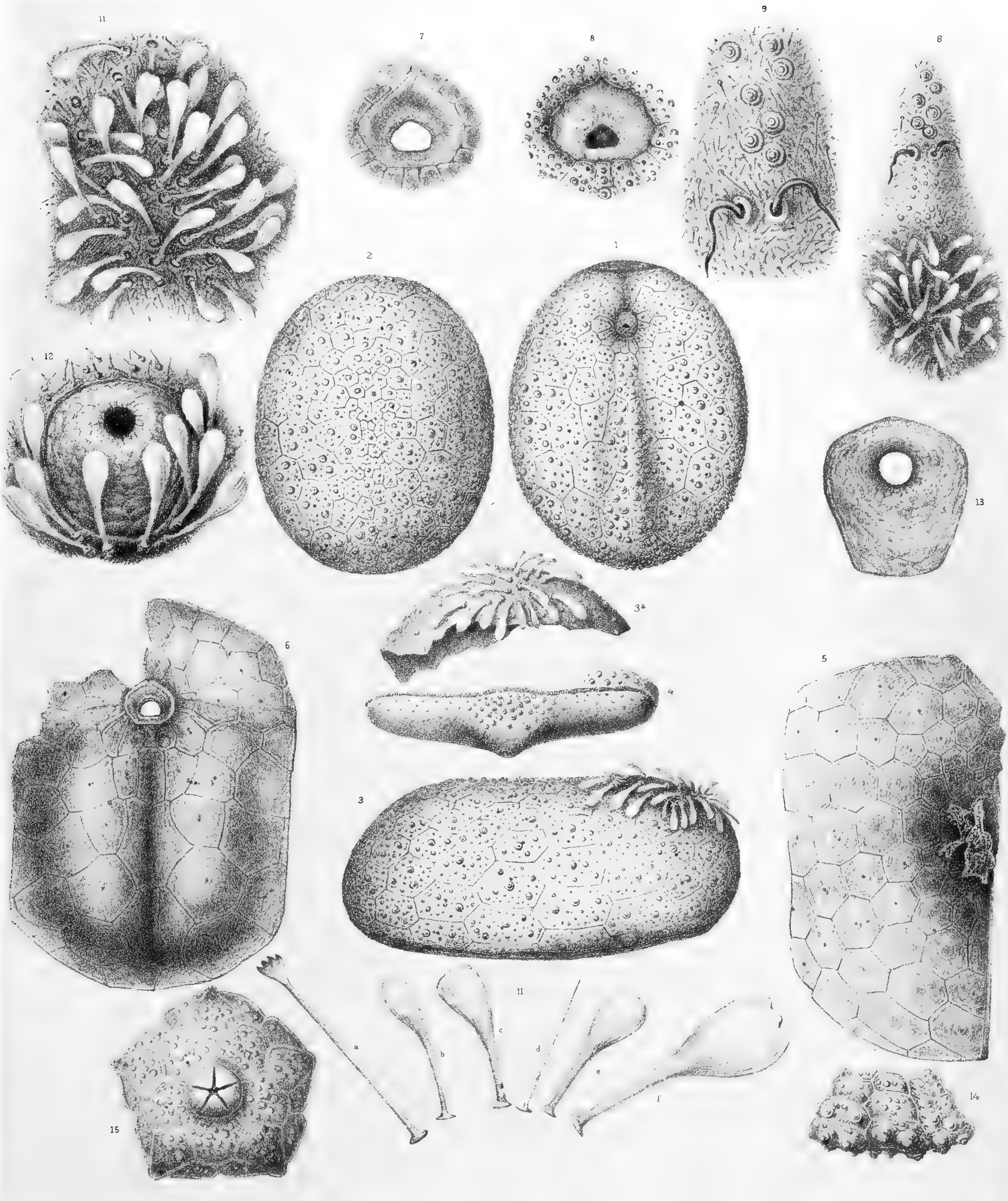

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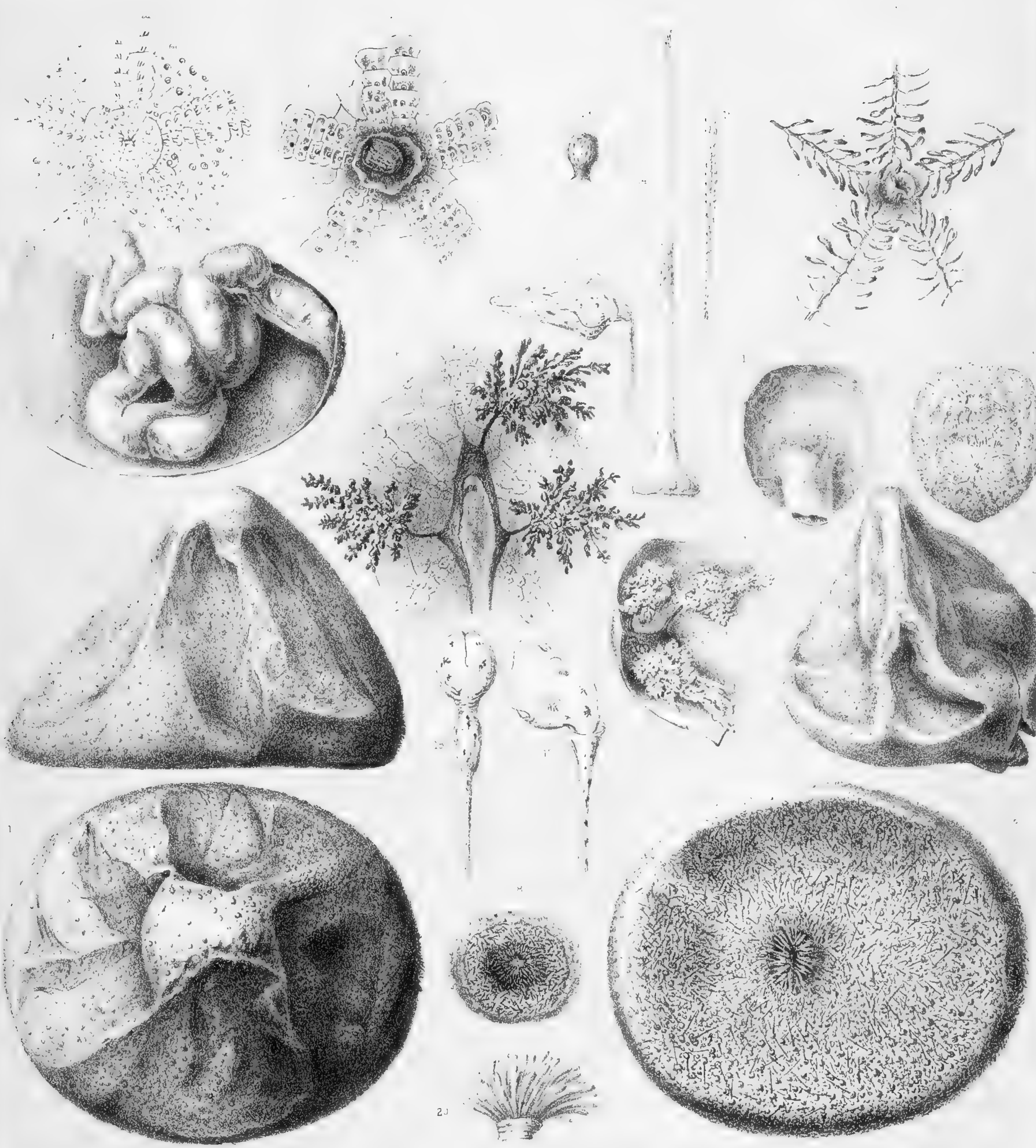

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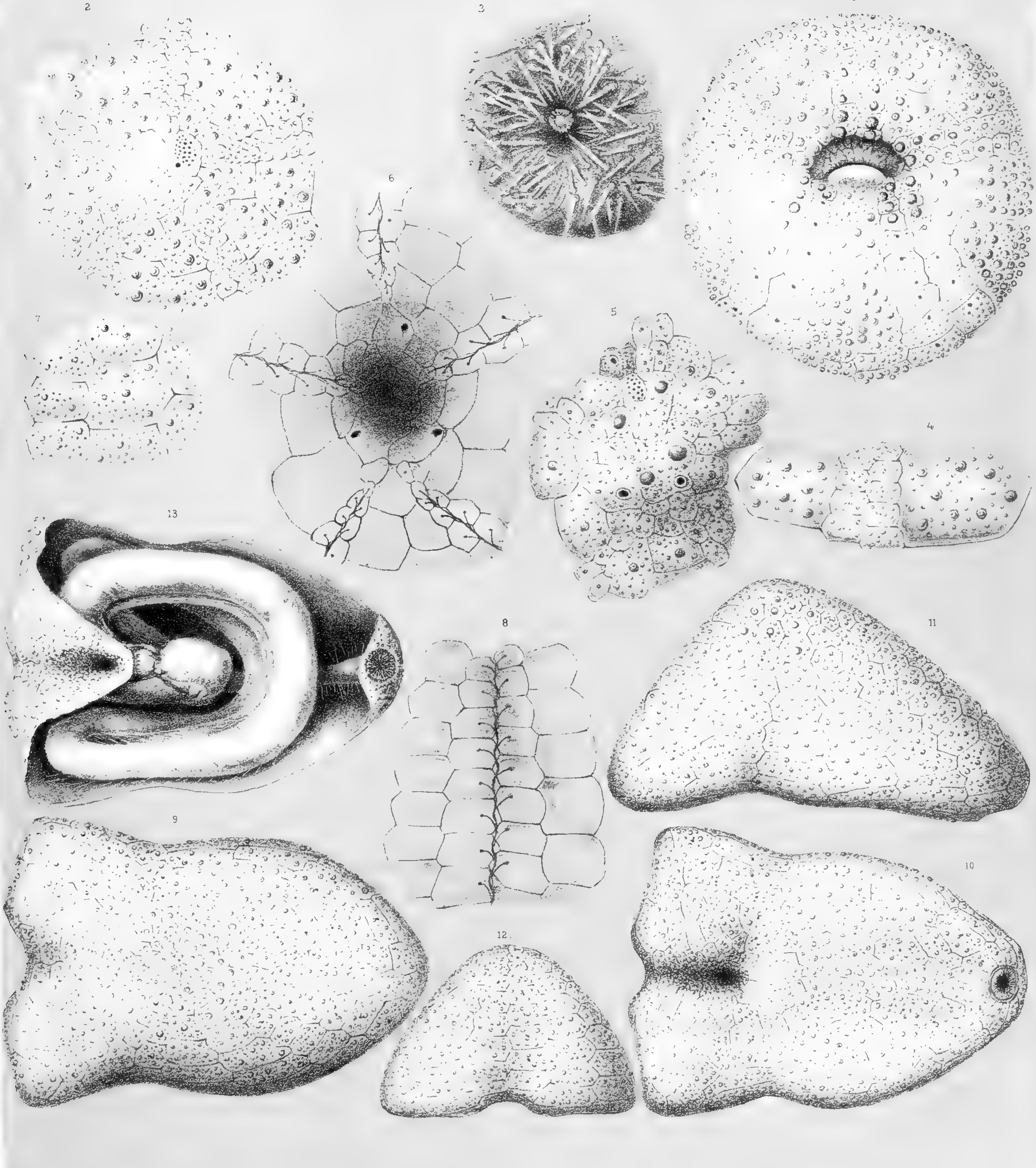

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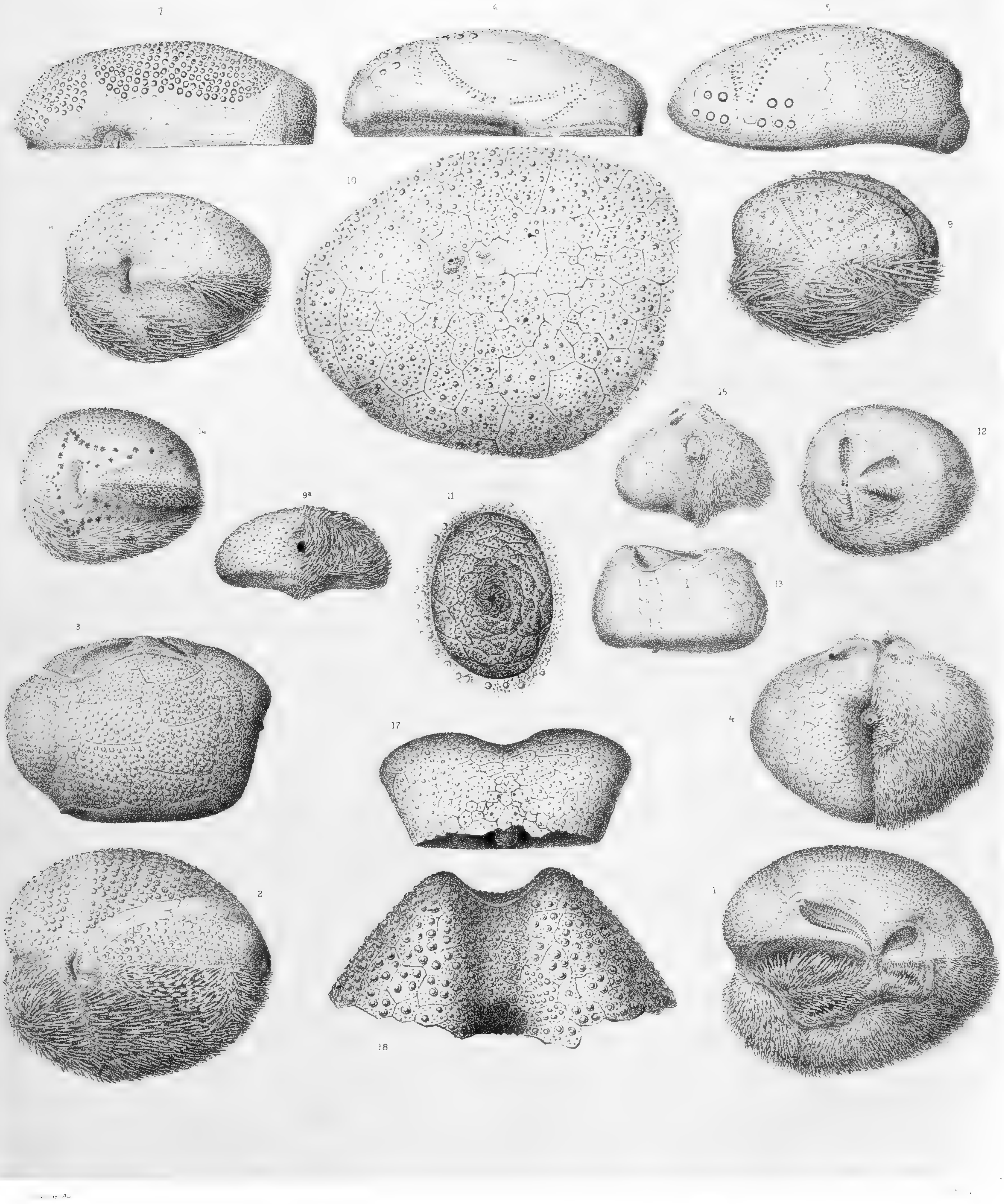
9-13 ECHINOCREPIS CUNEATA. A.Ag.



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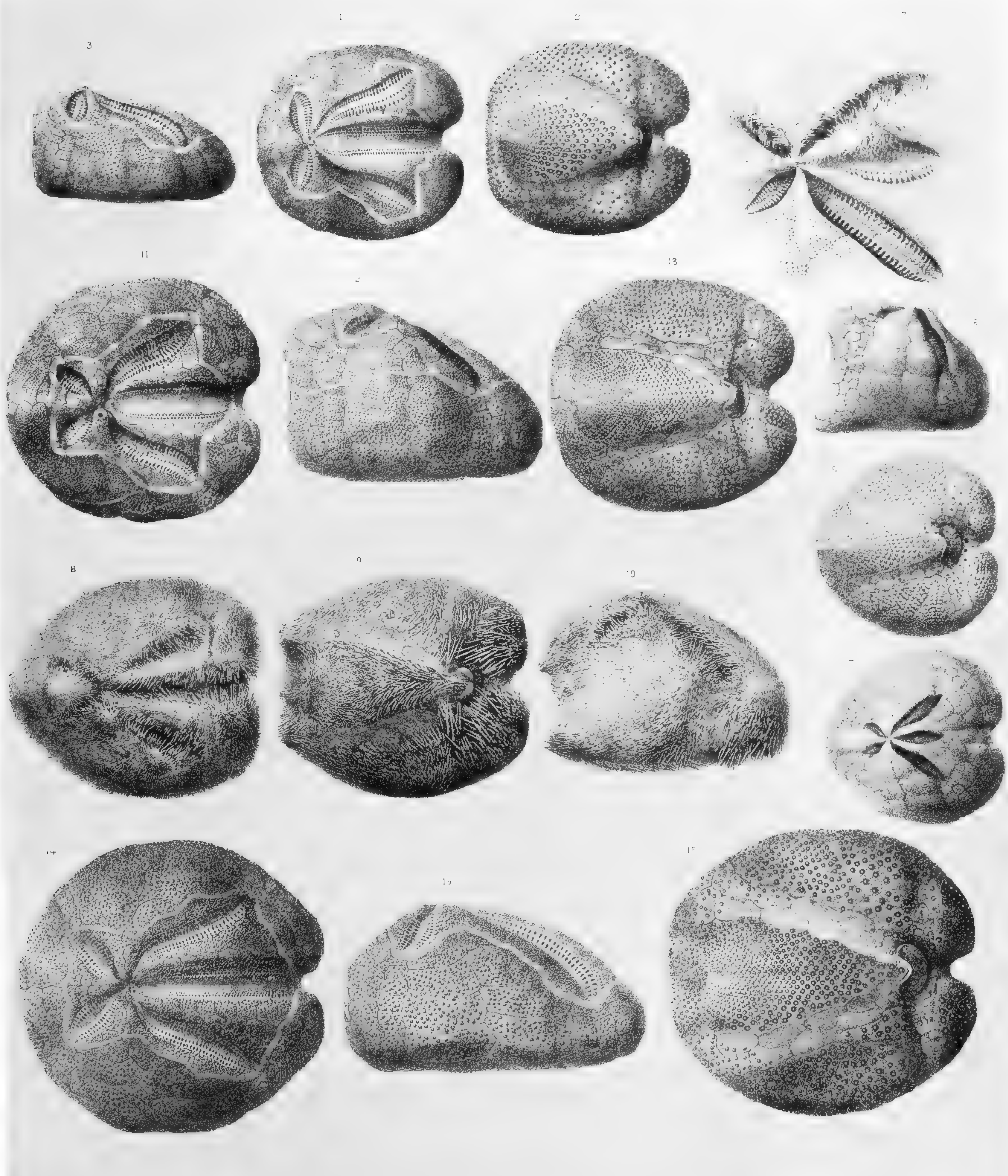
12-15 RHINOBRISSUS HEMIASTEROIDES A.Ag. 17 POURTALESIA CERATOPYGA A.Ag. 18 CIONOBRISSUS REVINCTUS A.Ag.



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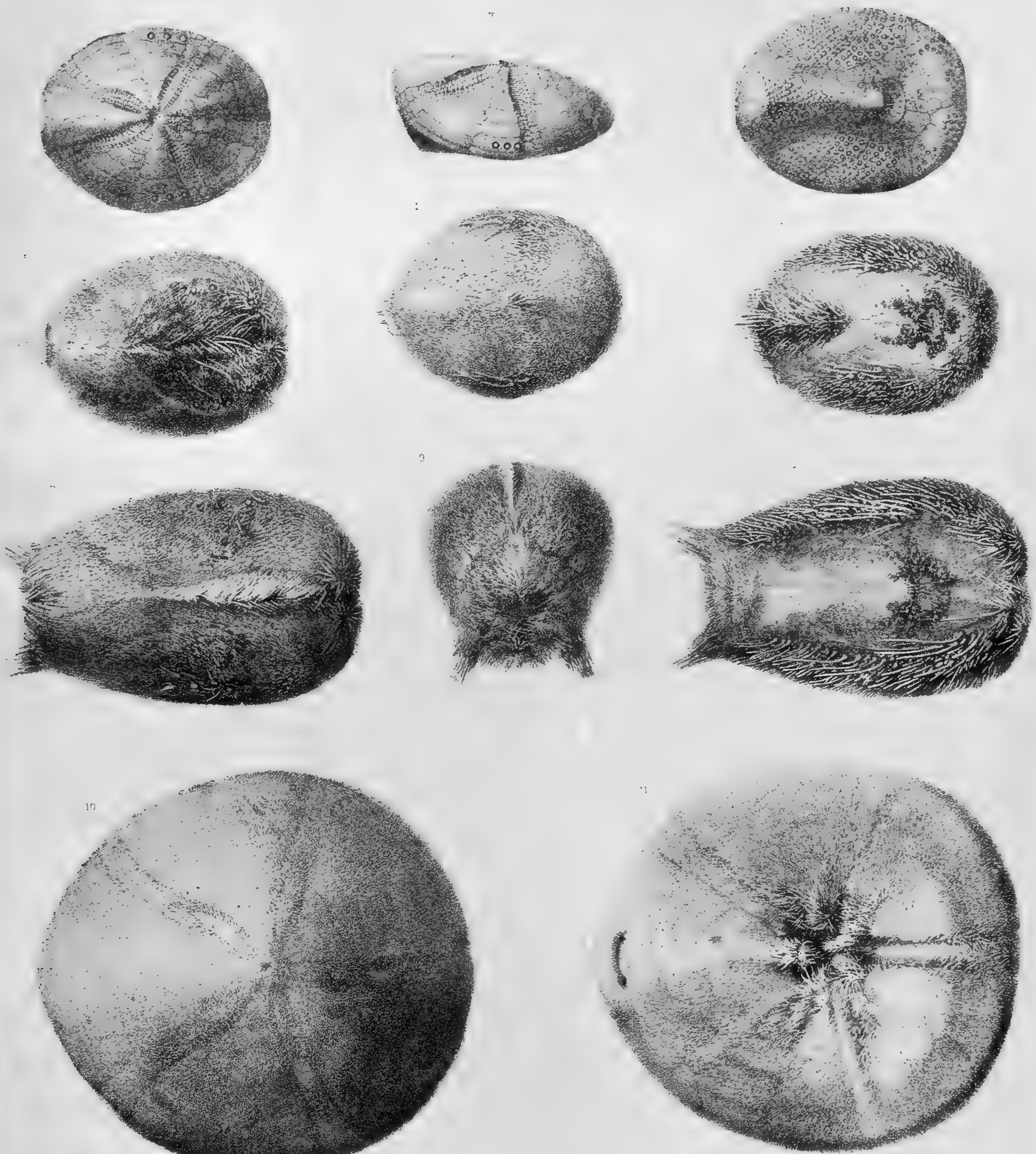
8 13 SCHIZASTER JAPONICUS A. Ag. 14 16 SCHIZASTER PHILIPPII



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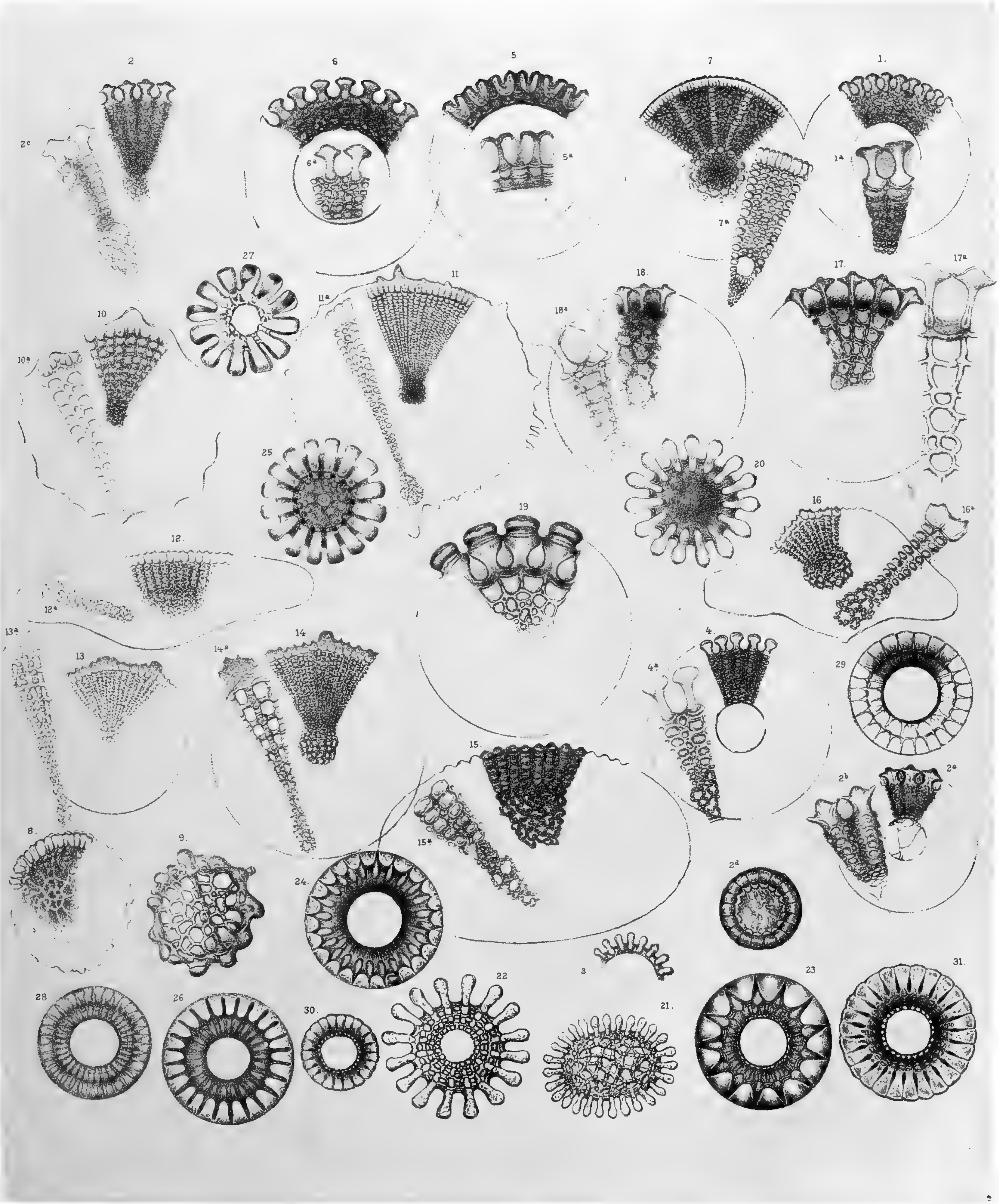
7–9 LOVENIA SUBCARINATA Gray. 10–11 ECHINOLAMPAS OVIFORMIS Gray.



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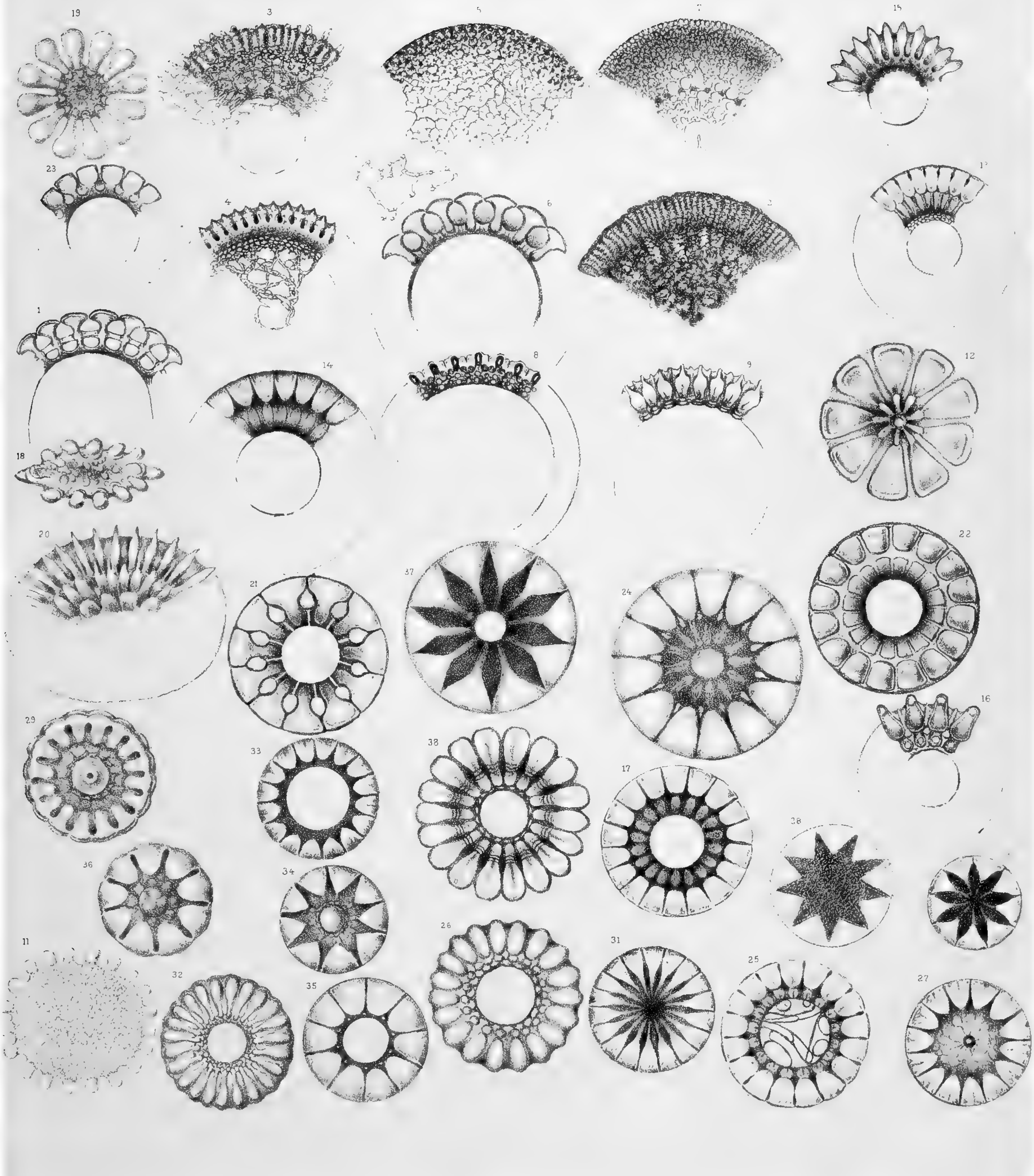

SECTIONS OF SPINES.

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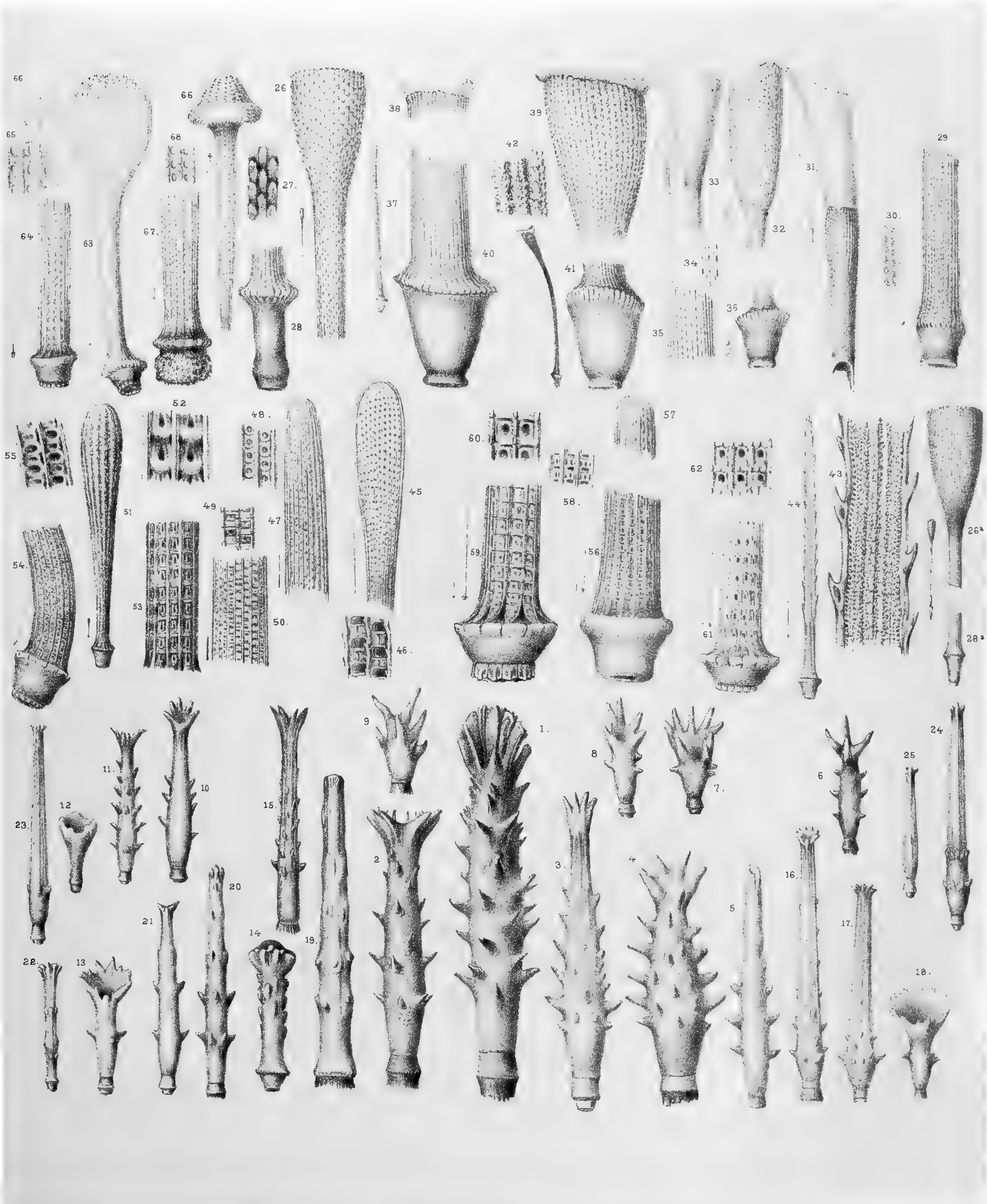
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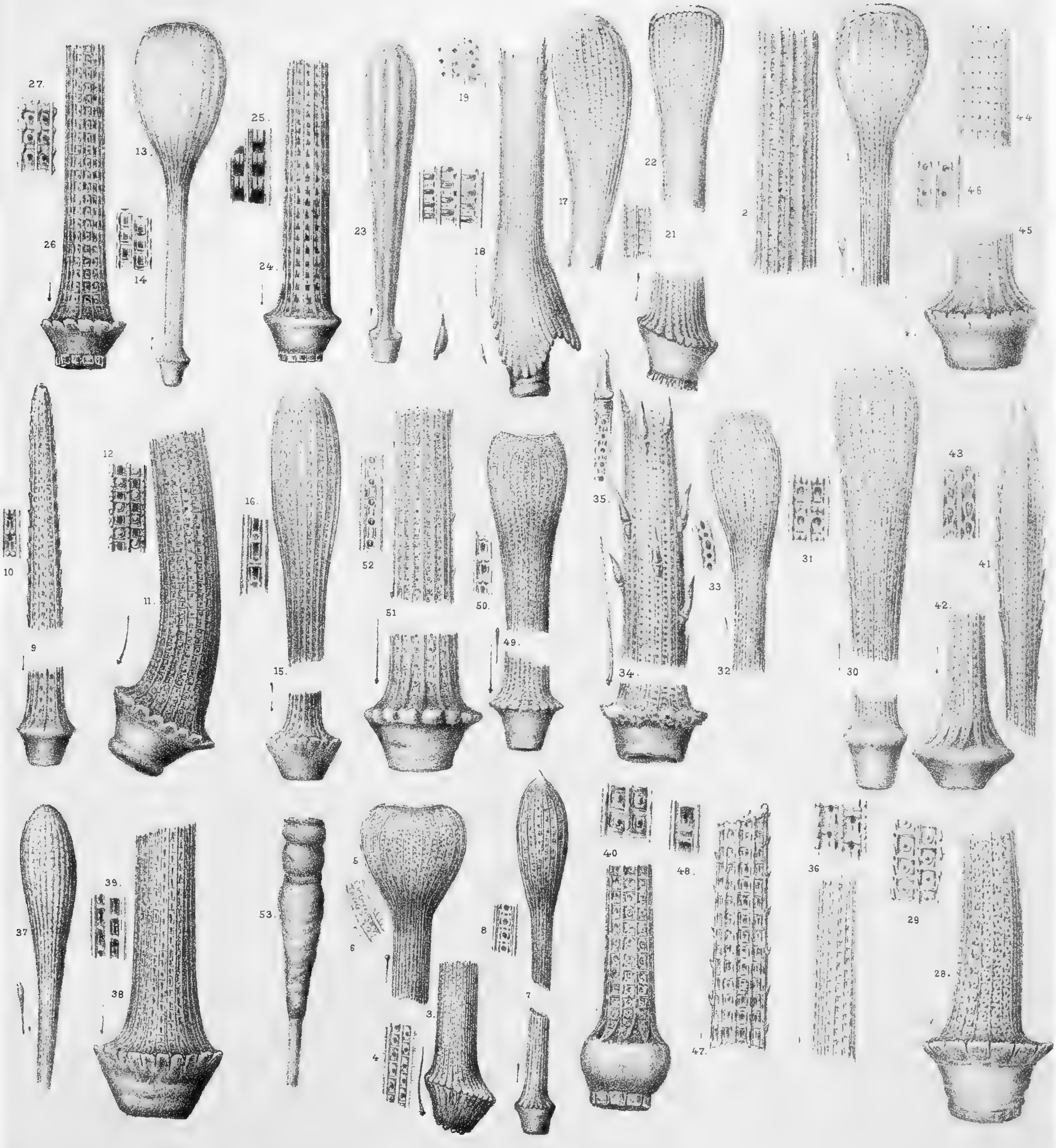
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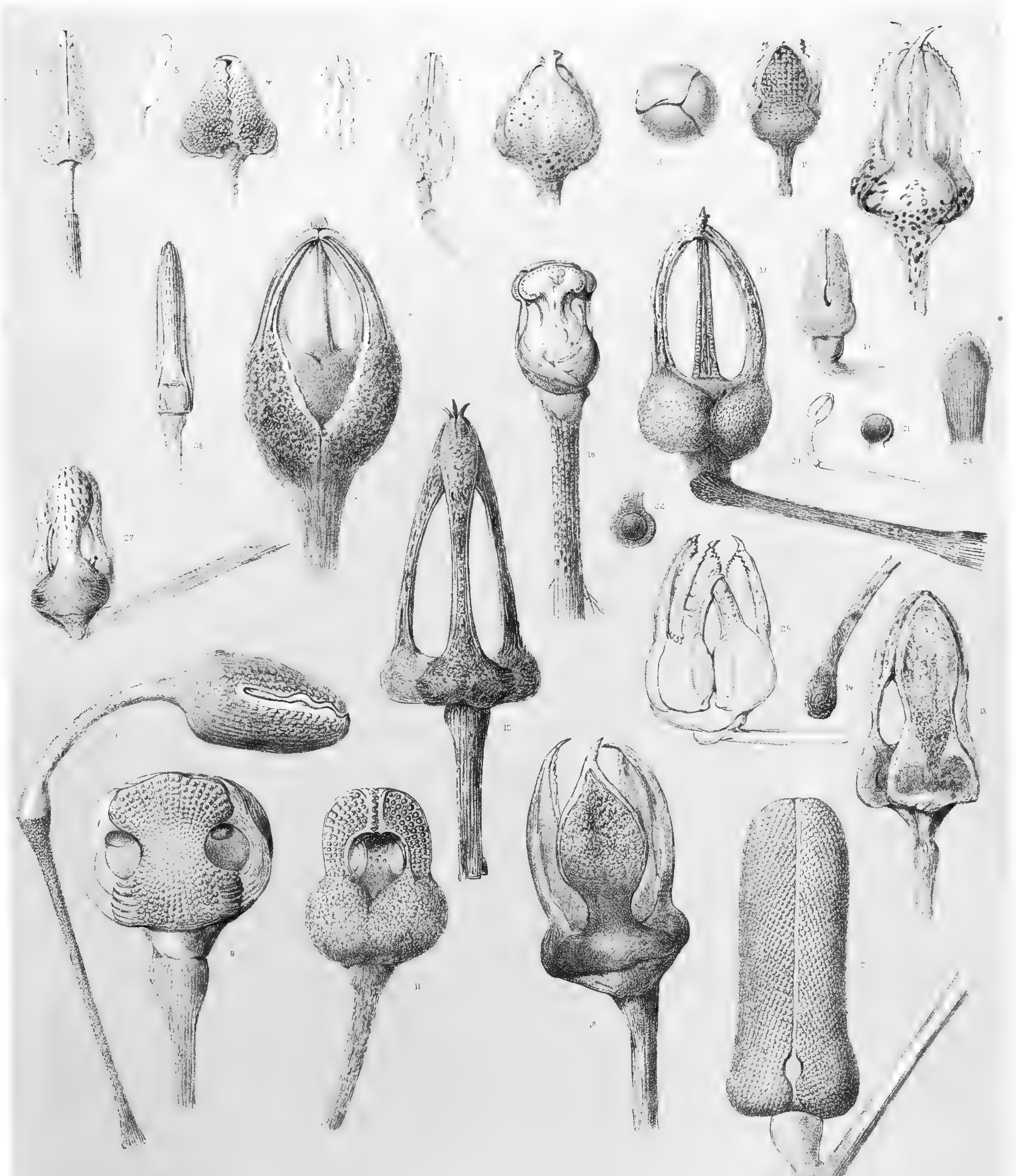
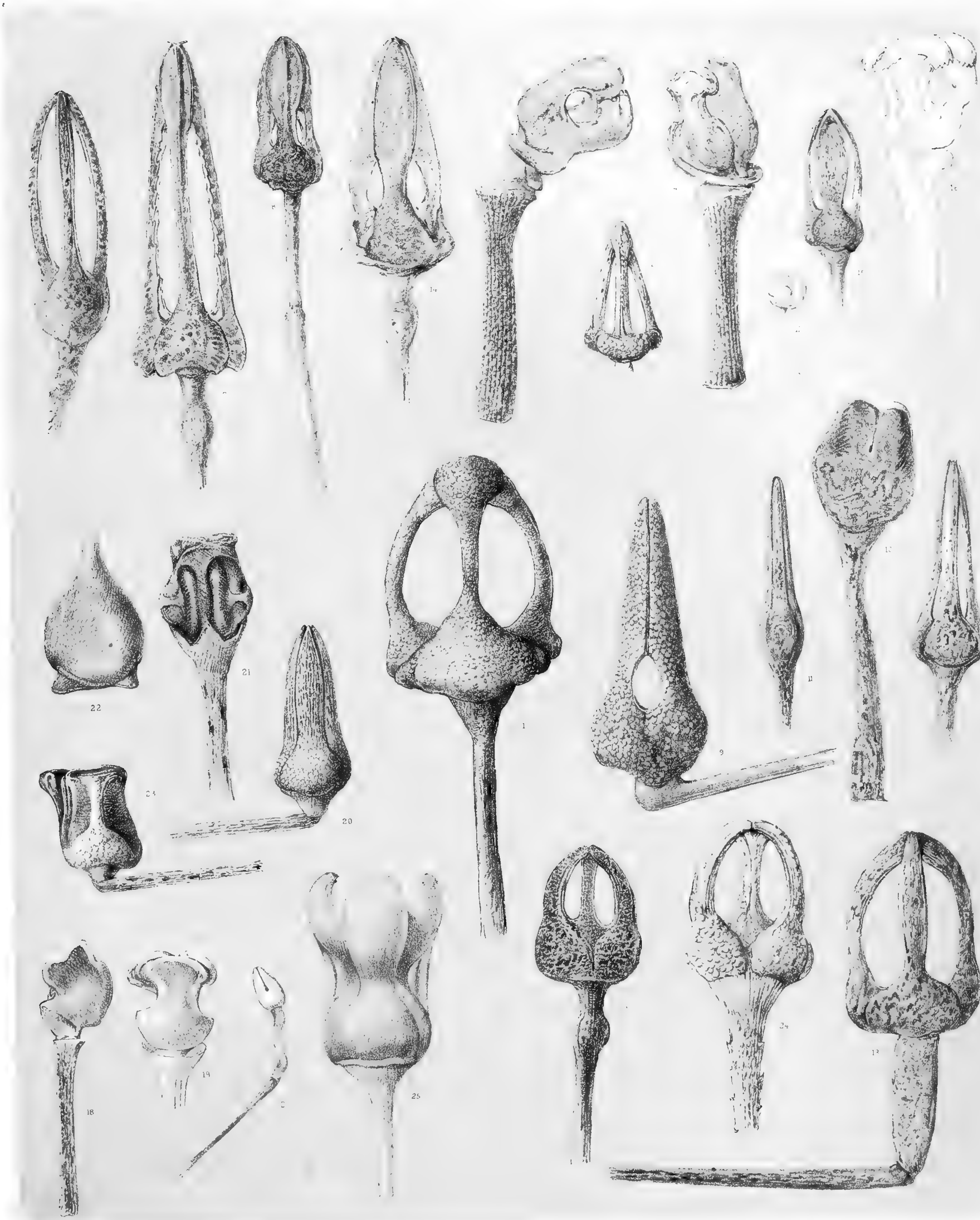
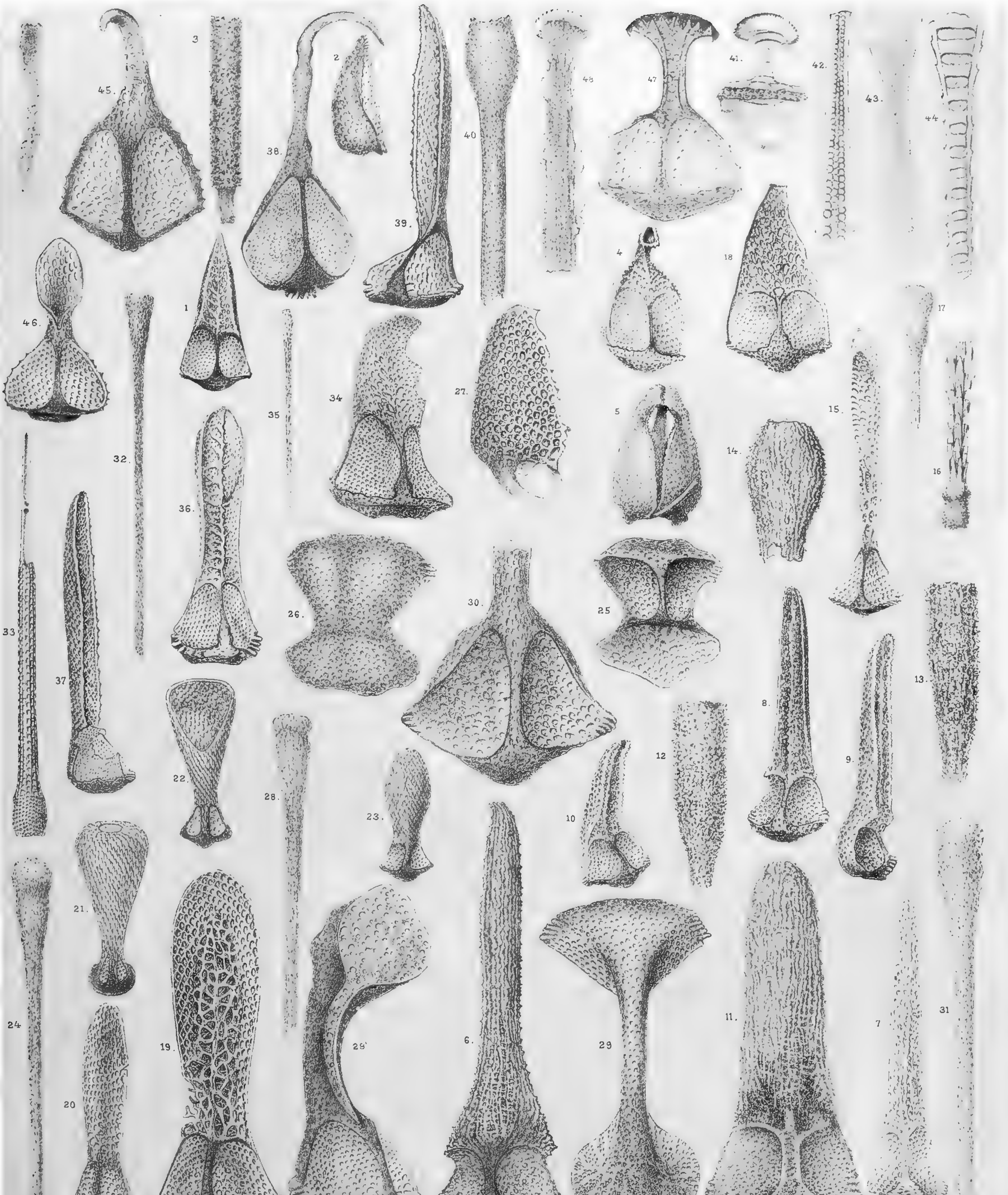


1 DOROCIDARIS 2 3 GONIOCIDARIS. 4 6 ASPIDODIADEMA 7-9 ECHINOTHURIAE

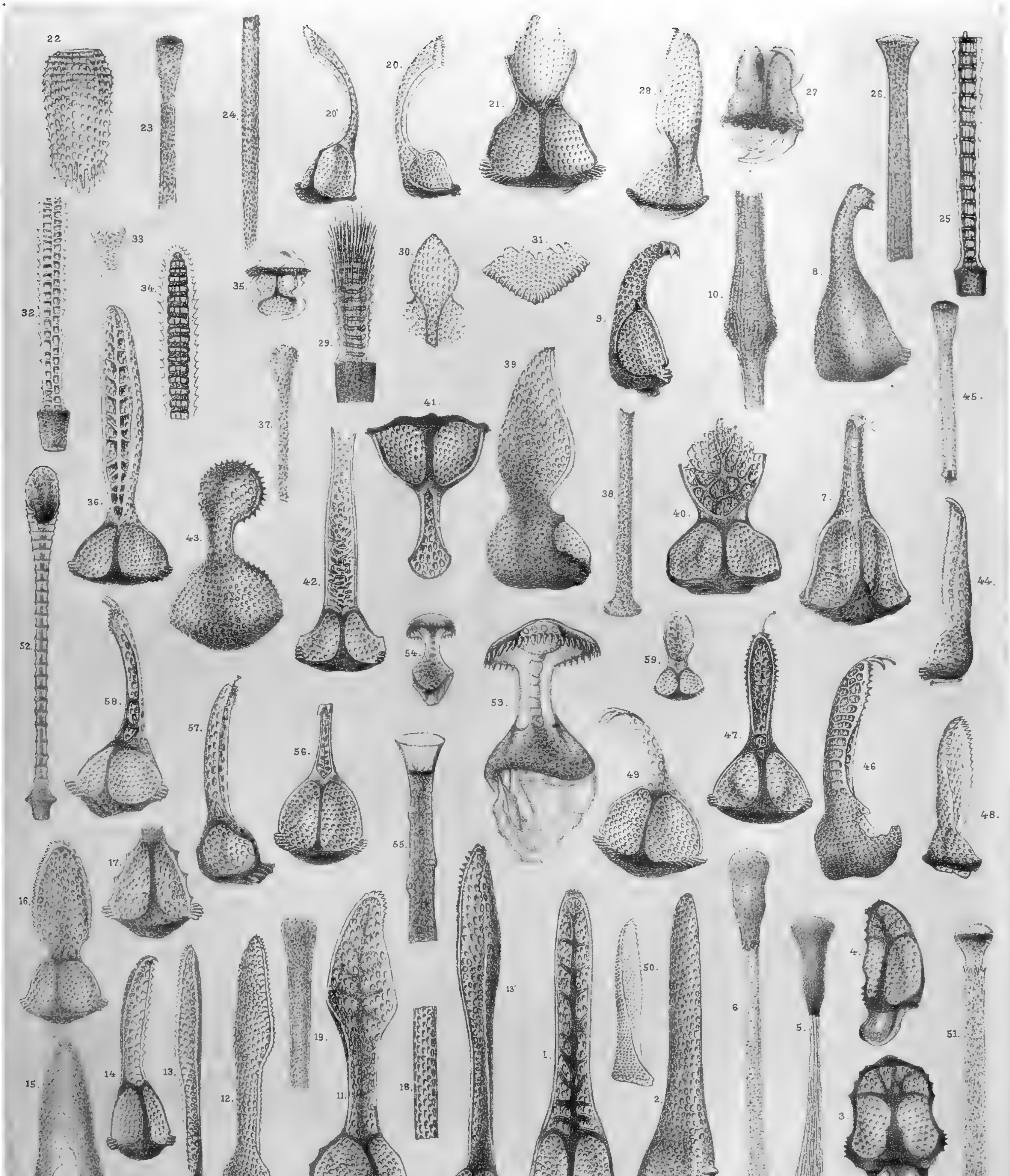
10 12 SPATACOCYSTIS 13-16 CYSTECHINUS 17 25 POURTALESIA 26 28 ACESTE



1-2 ECHINOTHURIAE. 3-5 ECHINOLAMPAS 6-8 LINOPNEUSTES. 9-12 CYSTECHINUS 13 GENICOPATAGUS
14 ECHINOCREPIS. 15-23 POURTALESIA. 24 CALYMNE 25 ACESTE. 26 SCHIZASTER



1-5 GONIOCIDARIS 6-14 POROCIDARIS 15-18 ASPIDODIADEMA. 19-31 PHORMOSOMA 32-36 ASTHENOSOMA
37 MICROPYGA. 38-40 PSEUDOBOLETIA. 41-44 ECHINOLAMPAS. 45-46 ACESTE.
47 48 CALYMNE



1-6 COELOPLEURUS. 7-10 SCHIZASTER. 11-19 LINOPNEUSTES. 20-24 GENICOPATAGUS.

25-36 CYSTECHINUS. 37-43 SPATAGOCYSTIS. 44-45 ECHINOCREPIS. 46-59 POURTALESIA.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the PYCNOGONIDA, dredged by H.M.S. Challenger during the years 1873–76. By Dr P. P. C. HOEK, Assistant at the Zootomical Laboratory of Leiden University.

THE beautiful and rich collection of PYCNOGONIDA formed during the expedition of the Challenger has been placed in my hands by Professor Sir Wyville Thomson, F.R.S., for description in the official report of the voyage.[1]

Our knowledge with regard to the Pycnogonids in general, their systematic arrangement, their geographical distribution, &c., is still very insufficient; and with respect to those of the greater depths of the ocean hardly anything is known.

The first attempt towards a monograph of the Pycnogonida is that of George Johnston.[2] His paper was published in 1837, and treats of the British species known up to that time. Though no special paper on Pycnogonids seems to have been published previous to Johnston's, yet there are several works of an older date, in which descriptions of species and genera belonging to this group occur, as well as discussions as to their place in the Zoological System. But as the descriptions are for the greater part very incomplete and the species therefore not to be recognised, these works are interesting only in so far as they show how much uncertainty has always been felt as to the place of the Pycnogonids among the Arthropoda.

Linnæus (1767)[3] brings the forms known to him under the genus *Phalangium*, in which also numerous land-spiders are placed, and which he ranges between *Hydrachna* and *Aranea* under his Insecta aptera.

[1] I wish to tender my sincere thanks to Professor Sir Wyville Thomson, F.R.S., &c., who liberally trusted to me—though a stranger—the drawing up of this report; at the same time to Mr John Murray who has kindly given me much valuable assistance.

[2] George Johnston.—An Attempt to ascertain the British Pycnogonidæ, in the Magazine of Zoology and Botany, conducted by W. Jardine, P. J. Selby, and G. Johnston, vol. i., 1837.

[3] Carolus Linnæus, Systema Naturæ, editio xii. rev., 1766.

Otho Fabricius (1780)[1] assigns to them the name *Pycnogonum* proposed by Brünnich, and places the *Cyamus ceti* with them in the same genus. He believes them to be most closely allied to Crustaceans.

J. C. Fabricius (1794)[2] places the two genera *Pycnogonum* and *Nymphon* along with *Pediculus*, *Acarus*, &c., in the eleventh class (the Antliata) of his entomological system.

Lamarck (1801)[3] gives the same genera (*Pycnogonum* and *Nymphon*) a place in the class of the Arachnida, order of the Palpistes, together with *Bdella*, *Acarus*, and *Hydrachna*.

Savigny (1816)[4] proposes to place the Pycnogonida among the Crustacea, an opinion afterwards embraced by Milne-Edwards (1834)[5] and Johnston (1837). According to Johnston, Savigny arrived at this conclusion by a very ingenious analysis of their organs. He pointed out that the proboscis of the *Pycnogonum* is a head, whereas the mandibles, palpi, and ovigerous organs are merely modifications of the legs, so that the Pycnogonida, like the Crustaceans, really have seven pair of legs, &c.

Johnston[6] himself, taking the assertions of Savigny as decisive, disagrees with those naturalists who object to the Pycnogonids being placed among the Crustaceans on account of the great simplicity of their anatomy. With Milne-Edwards he considers the Pycnogonids, although imperfect and even degraded, as formed on the same general plan as that of all the numerous other animals rightly placed in the class Crustacea.

There can be no doubt that Johnston's publication is one of the most important in the history of the knowledge of the group. Johnston gives a very clear description of the body of a Pycnogonid, fully discusses the systematic position of the order, proposes good characteristic marks for the genera, and enters into detailed descriptions of the species. The number of genera in his paper amounts to five (*Nymphon*, *Pallene*, *Orithyia*, *Phoxichilus*, *Pycnogonum*), each with one species, with the exception of the genus *Nymphon*, to which two species are assigned.

Of the authors who come after Johnston, Milne-Edwards is the first to be mentioned. In the third volume of his Histoire naturelle des crustacés (1840), he gives a very short description of the body of a Pycnogonid, and enumerates, but without paying special attention to the group, the species and genera known to him. Following Johnston as nearly as possible, he has the same five genera[7] and almost the same species. His descriptions are very insufficient; his work derives importance only from the circumstance that he places—as I have already mentioned above—the Pycnogonids among the Crustaceans as a distinct order, viz., that of the Araneiformes.

[1] Othonis Fabricii Fauna Groenlandica, Hafniæ et Lipsiæ, 1780.

[2] Joh. Christ. Fabricii Entomologia Systematica emendata et aucta, tom. iv., 1794.

[3] J. B. Lamarck.—Système des animaux sans vertèbres, à Paris, an. ix., 1801.

[4] J. C. Savigny.—Mémoires sur les animaux sans vertèbres, première partie, 1816.

[5] H. Milne-Edwards.—Histoire naturelle des Crustacés, tom. i.–iii., 1834–40.

[6] In this introduction only the most important authors are mentioned; a much fuller list is given by Johnston in his An Attempt, &c., and by Milne-Edwards, *loc. cit.*

[7] The name *Orithyia* of Johnston "étant déjà employé pour un autre genre de Crustacé," is changed by Milne-Edwards into *Phoxichilidium* (*l.c.*, p. 535).

The species of the English coast found (1842–44) a new monographer in Goodsir,[1] who in three consecutive papers enumerates a large number of species new to the fauna of the British Isles and to science in general. Two new genera (*Pephredo* and *Pasithoe*) are proposed by him, but owing to the want of detail Mr Goodsir's papers are of little value, for it is absolutely impossible to recognise either his new genera or his new species from such descriptions as he gives.

Of as little value is the list given by Hodge (1864),[2] in which all Goodsir's species are found, in addition to some new *Ammotheas* and species of his new genus *Achelia*. Since Hodge's list—though occasionally in English periodicals short descriptions of new species have been published—no special paper on the Pycnogonids of the English coast has appeared.

Those of the Norwegian coast found a very able describer in Kröyer (1845),[3] who gives very clear diagnoses of the genera and species. As a new genus he proposes *Zetes*, and the total number of species described by him is twelve. These descriptions were published without illustrations; but illustrations to the text may be found in Quoy and Gaimard's Voyages en Scandinavie, Laponie, &c., Zoologie, Crustacés, pl. xxxix. (1840).

For the Pycnogonids of Northern Europe and the coasts of the Arctic Ocean, besides Kröyer, the following authors must be mentioned:—Otho Fabricius[4] for the coast of Greenland, as mentioned above. Sabine[5] (1824) describes two *Nymphons* (*N. grossipes* and *N. hirsutum*) and a species of *Phoxichilus* (*P. proboscideus*—a true *Colossendeis*, Jarzynsky), found on the shores of the North Georgian Islands. Bell (1855),[6] in Belcher's Last of the Arctic Voyages, gives descriptions and drawings of two new species of *Nymphon* (*N. hirtipes* and *N. robustum*) common in higher northern latitudes. Jarzynsky (1870)[7] enumerates the species of Russian Lapland and the White Sea. A new genus (*Colossendeis*) is proposed by him. Buchholz (1874),[8] in the narrative of the second German North Polar Expedition, enumerates three species of *Nymphon*, but none of these are new.

[1] Harry D. S. Goodsir.—Edinburgh New Philosophical Journal, vol. xxxii., 1842; *ibid.*, vol. xxxiii., 1842; On the Specific and Generic Characters of the Araneiform Crustacea, Annals and Mag. of Nat. Hist., vol. xiv., 1844.

[2] George Hodge.—List of the British Pycnogonoidea, with descriptions of several new species, Ann. and Mag. of Nat. Hist., vol. xiii., 3d series, 1864.

[3] Henrik Kröyer.—Bidrag til Kundskab om Pyknogoniderne eller Sospindlerne, Natur-historisk Tidskrift, Ny Raekke, i., 1845.

[4] *Loc. cit.*

[5] A Supplement to the Appendix of Captain Parry's Voyage for the Discovery of a North-West Passage in the years 1819–20, containing the Zoological and Botanical Notices, London, 1824; Marine Invertebrate Animals, by Captain Edward Sabine.

[6] Thomas Bell.—Account of the Crustacea of the Last of the Arctic Voyages in Search of Sir John Franklin, under the command of Captain Sir E. Belcher, C.B., &c., in two volumes, vol. ii., 1855.

[7] Th. Jarzynsky.—Promissus catalogus Pycnogonidarum inventarum in mari glaciali ad oras Lapponiæ rossicæ et in Mari albo, anno 1869 et 1870, Annales de la Soc. des Natur. de St Petersb., 1870.

[8] R. Buchholz.—Crustaceen der Zweiten Deutschen Nordpolarfahrt, Anhang: Pycnogonida Die Zweit Deutsche Nordpolarfahrt, ii. 396, 1874.

Heller (1875)[1] proposes two new species of the same genus gathered during the Austrian North Polar Expedition; both are identical with species described before under other names.

In 1877 and again in 1879 G. O. Sars[2] published lists of the Pycnogonids gathered during dredging cruises in the northern part of the North Atlantic, on the coast of Norway, &c. There are in all four new species of *Nymphon* (*N. megalops*, *N. macronyx*, *N. serratum*, and *N. pallenoides*), a new genus, *Ascorhynchus*, with the species *Ascorhynchus abyssi*, a new species of *Colossendeis* (*C. angusta*), and a new *Pallene*, *P. malleolata*.

Miers (1877)[3] treats of the Pycnogonids collected during the last English Arctic Expedition. He gives two species, neither of which is new, and describes a variety of *Nymphon hirtum*.

In regard to the coast of Germany and the Netherlands not a single species has been recorded which is not found on the English coast. Occasionally enumerations of species have been published by Frey and Leuckart,[4] and Böhm.[5] In a paper I published myself (1877)[6] I described the four genera, species of which are found on the Dutch coast.

The Pycnogonids of the French coast have been studied by Quatrefages (1844),[7] Claparède (1863),[8] Hesse (1867–74),[9] and Grube (1868–72).[10] Their studies resulted in the proposal of a new species of *Ammothea* (*A. pycnogonoides*, Quatr.), of a new *Phoxichilidium* (?) (*P. cheliferum*, Claparède), a new species of *Phoxichilus* (*P. lævis*, Grube, and two new genera (?) *Oiceobathes*, Hesse, and (?) *Oomerus*, Hesse, both very insufficiently described. The Pycnogonids found on the coasts of France, the British Isles, Germany, &c., are not yet sufficiently well known to allow of their geographical distribution being discussed.

About the species of the Mediterranean very little is known. Philippi (1843)[11] and

[1] Camil Heller.—Die Crustaceen, Pycnogoniden, und Tunicaten der K. K. Oester. Ungar. Nordpol. Expedition, Denkschriften der Mathematisch-Naturwiss. Classe der K. Akad. der Wissensch., Bd. xxxv., Wien, 1875.

[2] G. O. Sars.—Prodromus descriptionis Crustaceorum et Pycnogonidarum, quae in expeditione Norvegica, anno 1876, observavit, Arch. f. Math. og Naturvid., ii., 1877; Crustacea et Pycnogonida nova, quae in itinere 2do et 3tio expeditionis Norvegicæ, anno 1877 et 1878, collecta (Prodromus descriptionis), *ibid.*, iv., 1879.

[3] Edward J. Miers.—Report on the Crustacea collected by the Naturalists of the Arctic Expedition in 1875–76, Annals and Mag. of Nat. Hist., fourth series, vol. xx., 1877.

[4] Frey and Leuckart.—Beiträge sur Kenntniss wirbelloser Thiere, 1847.

[5] R. Böhm.—Ueber die Pycnogoniden des Königl. Zool. Museums zu Berlin, Monatsber. der Königl., Akad. der Wiss. 1879.

[6] P. P. C. Hoek.—Ueber Pycnogoniden, Niederl. Archiv. f. Zoologie, iii., 1877.

[7] A. de Quatrefages.—Mémoire sur l'organisation des Pycnogonides, Ann. d. Sc. Natur., 3me Série, Zoologie, tom. iv., 1845.

[8] A. René Edouard Claparède.—Beobachtungen über Anatomie und Entwickelungsgeschichte wirbelloser Thiere an der Küste von Normandie angestellt, 1863.

[9] Hesse.—Annales des Sciences naturelles, 5ième Série, vii., 1867; *ibid.* 5ième Sèrie, xx., 1874.

[10] Edward Grube.—Mittheilungen über St Malo und Roscoff und die dortige Meeres besonders die Anneliden-fauna, 1869; Mittheilungen über St Vaast la Hougue, und seine Meeres, besonders seine Anneliden-fauna, Verhandl. der Schlesischen Gesellsch. f. vaterl. Cultur., 1869.

[11] A. Phillipi.—Ueber die Neapolitanischen Pycnogoniden, Arch. f. Naturgesch, ix., 1843.

Costa (1838–61)[1] published short notes on the Pycnogonids found there. Philippi proposed a new genus (*Endeis*), which is perhaps identical with *Pasithoe*, Goodsir; and a second genus (*Pariboea*), with the species *Pariboea spinipalpis*. Costa introduces (1838) the genus *Phanodemus*, in all probability identical with *Pephredo*, Goodsir; in his Microdoride mediterranea (1861) he proposes three new genera: *Rhynchothorax*, *Platychelus*, and *Alcynous*. From the Gulf of Naples Costa knows in all seven species, whereas the total number of species of the Mediterranean found in Philippi's paper is only four. A monograph on the Pycnogonids of the Mediterranean, and especially of the Gulf of Naples, will very probably soon appear; it will form the second part of the Studi e Ricerche di Cavanna (1877),[2] and will also be published by Dohrn, as announced in his Neue Untersuchungen (1878).[3]

Of all Pycnogonida, those found on the west coast of North America are best known. Careful attention was paid to them by Stimpson (1852),[4] Verrill, Smith (1874),[5] but especially by Wilson (1878–80),[6] who in his Pycnogonida of New England, enumerates fourteen species belonging to nine genera, two of which (*Pseudopallene* and *Anoplodactylus*) are new to science. Though I do not believe that these new genera after a careful examination will hold good, and though I think it a pity that Wilson in his researches has not taken advantage of recent investigations (especially those of Cavanna), yet there can be no doubt, I believe, that his paper is one of the best descriptive publications after those of Johnston and Kröyer.

For the other countries of our globe, a very brief enumeration may suffice. As far as I have been able to ascertain, by far the greater number of the species described are littoral; from the open ocean very few species are recorded. Two species described by White (1847),[7] inhabiting the South Sea, are exceptions. White describes them as species of *Nymphon*, whereas I believe that they ought to be considered as *Phoxichilidiums*. From the open ocean are also those species (one of *Nymphon*, another of *Phoxichilidium*) mentioned by Grube (1869)[8] as occurring in the China Sea. Grube's descriptions as well as those of White are extremely incomplete.

Wood-Mason (1873)[9] described a species of a genus which he believed to be new,

[1] O. G. Costa.—Fauna del Regno di Napoli, Crostacei et Aracnedi, Napoli, 1838; Microdoride mediterranea, tomo primo, Napoli, 1861.

[2] G. Cavanna.—Studi e Ricerche sui Picnogonidi, parte prima (Publicazioni del R. Istituto di Studi superiori pratici et di perfezionamento in Firenze, Sezione di Scienze fisiche e naturali), Firenze, 1877.

[3] A. Dohrn.—Neue Untersuchungen über Pycnogoniden, Mittheil. a. d. Zoologischen Station zu Neapel, i., 1879.

[4] William Stimpson.—Synopsis of the Marine Invertebrata of Grand Manan, Smithsonian Contributions to Knowledge, January 1853.

[5] Smith in Report on the Invertebrata of Vineyard Sound. In Part I. of the Report on the Condition of the Sea-Fisheries of the South Coast of New England, 1873.

[6] E. B. Wilson.—Descriptions of Two New Genera of Pycnogonida, American Journal of Science and Arts, vol. xv., 1878; Synopsis of the Pycnogonida of New England, Transactions of the Connecticut Academy, vol. v., 1880.

[7] Adam White.—Descriptions of New or Little-Known Crustacea in the Collection at the British Museum, Proceedings of the Zoological Society of London, part 15, 1847.

[8] E. Grube in Jahresbericht der Schlesischen Ges. für vaterländische Cultur, Breslau, 1869.

[9] James Wood-Mason.—On *Rhopalorhynchus kröyeri*, a new Genus and Species of Pycnogonida, with plate xiii., Journal of the Asiatic Society of Bengal, part 2, 1873.

and called *Rhopalorhynchus.* There can be no doubt that this is the same as the genus formerly (1870) described by Jarzynsky[1] as *Colossendeis.* Wood-Mason's species is an inhabitant of Port Blair, Andaman Islands.

Miers (1875 and 1879)[2] mentions two species of *Nymphon,* and one of a new genus, which he calls *Tanystylum,* and which is nearly allied to *Achelia.* These species were collected at Kerguelen Island during the visit of the English and American Transit of Venus expeditions to that Island. Böhm (1879)[3] has made a very careful study of the Pycnogonids of the Royal Zoological Museum at Berlin. He describes two species of *Nymphon* and one of *Achelia,* as collected at Kerguelen; one species of *Nymphon* collected south of the Cape of Good Hope, one *Pallene* (?) taken in the Straits of Magellan, another *Pallene* from Mozambique, a *Phoxichilidium* and a *Phoxichilus* collected in the neighbourhood of Singapore; finally, besides some species from Northern Europe, three species found near Enosima (Japan); one species of a new genus, which Böhm calls *Lecithorhynchus,* one *Ascorhynchus* (*Gnamptorhynchus,* Böhm), and one species of *Pallene.* Slater (1879)[4] published a short paper on a new genus of Pycnogonids (*Parazetes*) found in Japan, and described in the same paper a variety of *Pycnogonum litorale* from the same country.

In the Boston Journal of Natural History, Eights (1836?) mentions the genus *Decalopoda,* but I have not been able to ascertain whether this is a good genus, nor where it has been found.[5] A species of *Pasithoe* described by Dr Gould[6] is, according to Wilson (*loc.cit.* p. 2), "indeterminable." To Mr Wilson's paper I am also indebted for the mention of a species of Pycnogonid found on the coast of Chili: it seems to be a species of *Pycnogonum.*[7]

In this enumeration the reader will not find a complete list of the descriptive literature of Pycnogonida, but all the more important publications, together with the greater number of the minor papers on our group are mentioned. With a few exceptions the zoological publications about Pycnogonids are very superficial, and this I believe is owing partly to the circumstance that many authors who have had no opportunity of comparing large collections of different forms have published descriptions of species and even of genera from the examination of such species only. To describe new species, however, ought

[1] Th. Jarzynsky, *loc. cit.*

[2] E. J. Miers.—Descriptions of new species of Crustacea collected at Kerguelen's Island, by the Rev. A. E. Eaton. Annals and Magazine of Natural History, fourth series, vol. xvi., 1875; Crustacea of Kerguelen Island, Philosophical Transactions, London, vol. clxviii.; extra volume, pp. 200–214, 1879, pl. xi.

[3] R. Böhm, *loc. cit.;* the same in Sitzungsberichte der Gesellschaft naturforschender Freunde in Berlin, 1879, pp. 53 and 140.

[4] Henry H. Slater.—On a new genus af Pycnogon (*Parazetes*) and a variety of *Pycnogonum littorale* from Japan, Ann. and Magaz. of Nat. History, 5th series, vol. iii., 1879.

[5] Boston Journal of Natural History, i. 204, t. 7. (See Cuvier's Animal Kingdom, London, Wm. S. Orr & Co. 1840. p. 468.)

[6] Proc. Boston Society Nat. Hist., vol. i. p. 92.

[7] Gay.—Historia fisica y politica de Chile, Zoologia, p. 308, pl. iv. fig. 8, 1854.

not to be the work of one who begins to study a group, as is often the case, but can only be done properly after laborious and continuous research. Moreover, the study of the literature is enormously encumbered by the circumstance, that descriptions of single species often lie buried in obscure periodicals. This circumstance, I hope, will be considered, when my report is found to be far from complete.

The collection of Pycnogonida brought home by the Challenger and placed in my hands numbers about 120 specimens. They were in an excellent state of preservation, and to facilitate the work, the bottles of spirit in which they were put, were furnished with labels indicating the station, latitude, longitude, bottom temperature, and the nature of the sea-bed where they were dredged. Some of the specimens were not obtained from any of the 361 dredging stations, but were collected on the shore (near Cape Town, *e.g.*), or dredged in shallow water (Bahia, Kerguelen). Over a course of 68,890 miles the dredge was let down at 361 stations, and Pycnogonids were procured on only twenty-six occasions. The 120 specimens of Pycnogonida brought home belong to thirty-six species, and thirty-three of these I have been obliged to consider and describe as new to science. The greatest depth where a Pycnogonid was found was 2650 fathoms; the greatest depth dredged during the cruise was 4575 fathoms.

In the following list I have given the range in depth at which species of Pycnogonida were found by the Challenger, and also recently during the cruise of the "Knight Errant":—

Shore,	*Discoarachne brevipes*, Hoek.
,,	*Hannonia typica*, Hoek.
7 to 20 fathoms,	*Phoxichilidium fluminense*, Kröyer.
,, ,, ,,	*Phoxichilidium insigne*, Hoek.
10 to 120 ,,	*Nymphon brachyrhynchus*, Hoek.
25 to 120 ,,	*Nymphon brevicaudatum*, Miers.
25 ,,	*Nymphon fuscum*, Hoek.
38 ,,	*Ascorhynchus minutus*, Hoek.
,, ,,	*Pallene languida*, Hoek.
38 to 40 ,,	*Pallene laevis*, Hoek.
38 to 120 ,,	*Pallene australiensis*, Hoek.
45, 55, 175 ,,	*Phoxichilidium patagonicum*, Hoek.
53 ,,	*Pycnogonum litorale*, Ström.
55, 70, 120 ,,	*Colossendeis megalonyx*, Hoek.
83 ,,	*Nymphon brevicollum*, Hoek.
83 to 540 ,,	*Nymphon grossipes*, Oth. Fabr., sp.
120 ,,	*Colossendeis robusta*, Hoek.
150 ,,	*Ascorhynchus orthorhynchus*, Hoek.
375 to 540 ,,	*Nymphon robustum*, Bell.
400 to 1600 ,,	*Colossendeis leptorhynchus*, Hoek.
515, 530, 540 ,,	*Nymphon strömii*, Kröyer.
540 ,,	*Nymphon macronyx*, G. O. Sars.
,, ,,	*Colossendeis proboscidea*, Sab., sp.
600 ,,	*Phoxichilidium patagonicum*, var. *elegans*, Hoek.

700	fathoms,	*Oorhynchus aucklandiæ*, Hoek.
825	„	*Nymphon perlucidum*, Hoek.
1100	„	*Nymphon longicoxa*, Hoek.
„	„	*Nymphon compactum*, Hoek.
1250	„	*Colossendeis minuta*, Hoek.
1375	„	*Ascorhynchus glaber*, Hoek.
1375 to 1600	„	*Nymphon hamatum*, Hoek.
„ „	„	*Colossendeis gigas*, Hoek.
„ „	„	*Colossendeis gracilis*, Hoek.
1600 to 1950	„	*Phoxichilidium pilosum*, Hoek.
1675	„	*Nymphon meridionale*, Hoek.
„	„	*Phoxichilidium oscitans*, Hoek.
1875	„	*Phoxichilidium mollissimum*, Hoek.
2160	„	*Nymphon procerum*, Hoek.
2225	„	*Nymphon longicollum*, Hoek.
„	„	*Colossendeis media*, Hoek.
2650	„	*Colossendeis brevipes*, Hoek.

The number of times at which Pycnogonida were dredged at certain depths is shown in the following table :—

99 dredgings in depths of from	1 to 500	fathoms,	26 times.
30 „ „	501 to 1000	„	3 „
47 „ „	1001 to 1500	„	3 „
47 „ „	1501 to 2000	„	4 „
93 „ „	2001 to 2500	„	2 „
83 „ „	2501 to 3000	„	Once (at 2650 fathoms).
11 „ „	3001 to 4575	„	None.

It thus becomes apparent that what Davidson has shown for the Brachiopoda, holds also in the case of the Pycnogonida, that they are very seldom found in depths exceeding 500 fathoms; out of about 100 dredgings in depths of from 1 to 500 fathoms, Pycnogonids were brought up twenty-six times, while in depths varying from 501 to 3000, they were obtained only thirteen times out of 300 dredgings.

The following statement shows the range in depth at which the genera of Pycnogonida hitherto known have been found. The total number is twenty-seven genera, of which eleven are true littoral forms. Of the sixteen remaining genera there are five of which I am quite uncertain as to the depth at which they are found, and four for which the depth does not exceed 50 fathoms. Then there are two (*Pallene* and *Pycnogonum*), which, as a rule, inhabit depths not exceeding 120 fathoms, but which in a single case were found at depths almost reaching 500 fathoms (*Pallene malleolata*, G. O. Sars, at a depth varying between 191 and 459 fathoms, and *Pycnogonum litorale*, dredged by Smith and Harger, at a depth of 430 fathoms). Hence there remain only five genera of Pycnogonida, species of which may truly be called deep-sea inhabitants; they are the genera *Nymphon, Ascorhynchus, Oorhynchus, Colossendeis*, and *Phoxichilidium*.

List of the Genera of Pycnogonida hitherto known.

Name of the Genus.	Number of Species Described.	Depth in Fathoms at which they have been found.	Geographical Distribution.
Nymphon, Fabr.,	38	Shore to 2225.	Mundane—Pacific Ocean excepted.
Ammothea, Leach,	5	Shore to 5.	American and European Coasts of the North Atlantic.
Böhmia, Hoek,	1	(?)	(?)
Phanodemus, Costa,	3	Shore.	Coast of Italy.
Rhynchothorax, Cos.,	1	(?)	North Coast of Africa.
Pephredo, Goodsir,	1	Shore.	Coast of England.
Platychelus, Cos.,	1	(?)	Coast of Sardinia.
Oiceobathes, Hesse,	1	Shore.	Coast of France.
Ascorhynchus, G. O. Sars,	5	38 to 1539	North Atlantic, Indian Ocean, South Coast of Australia, North of New Guinea, Coast of Japan.
Zetes, Kröyer,	1	Shore.	Coast of Greenland.
Parazetes, Slater,	1	(?)	Japan.
Pariboea, Philippi,	1	Shore.	Coast of Italy.
Achelia, Hodge,	4	Shore to 35.	American and European Coasts of the North Atlantic, Coasts of the Mediterranean, Kerguelen.
Alcinous, Cos.,	2	(?)	Coast of Italy.
Tanystylum, Miers,	2	5 to 7	Kerguelen, East Coast of North America.
Lecithorhynchus, Böhm,	2	3 to 4	Japan.
Oorhynchus, Hoek,	1	700	Auckland.
Colossendeis, Jarzynsky,	12	55 to 2650	Mundane—Pacific Ocean excepted.
Pasithoe, Goodsir,	1	Shore.	Coast of England.
Endeis, Philippi,	2	Shore.	Coast of Italy.
Discoarachne, Hoek,	1	Shore.	Coast of Cape Colony.
Pallene, Johnston,	16	Shore to 459.[1]	Coast of Northern Europe, Greenland Sea, Coast of Greenland, East Coast of North America, Coast of Mozambique, off Australia, China Sea, Coast of Japan.
Phoxichilidium, M.-Edwards,	15	Shore to 1950.	Coast of Northern Europe, Greenland, North America, North Atlantic, Coast of Brazil, Patagonia, South Atlantic, Indian Ocean, Coast of Lower Siam, off Japan.
Oomerus, Hesse,	1	Shore.	Coast of France.
Hannonia, Hoek,	1	Shore.	Coast of Cape Colony.
Phoxichilus, Latr.,	4	Shore.	Coasts of Northern Europe, Mediterranean Coast, Coast of Lower Siam.
Pycnogonum, Brünnich,	2	Shore to 430.[2]	Coasts of Northern Europe, East Coast of North America, Coast of Chili, Coast of the Mediterranean, Coast of Australia.

[1] Teste G. O. Sars.

[2] Smith and Harger, teste Wilson.

When comparing the bathymetrical range of the different genera with their geographical distribution, it is easily remarked that it is the genera most widely spread over the bottom of the sea which are capable of existing at the greatest variety of depth. This is, for instance, the case with *Nymphon*, *Colossendeis*, and *Phoxichilidium*. Some species of *Nymphon* are found at low-water mark, others inhabiting shallow water in the immediate neighbourhood of the coast are dredged at a depth of under 100 fathoms; others again are never found at a depth exceeding 800 fathoms, and finally, there are some which are true deep-sea species. Some species of *Colossendeis* were dredged at a depth of under 100 fathoms, other species inhabit the ocean at a depth not exceeding 800 fathoms, and others were dredged at depths varying from 800 to 2800 fathoms. The genus *Phoxichilidium* shows almost the same bathymetrical range as *Nymphon*. Now the geographical range of these three genera is, as far as I could ascertain from the facts at my disposal, nearly the same; this distribution is mundane. With the exception of the Pacific Ocean, from which as yet not a single species of Pycnogonid has been obtained, representatives of these three genera are found almost in every sea.

Of the genus *Ascorhynchus* only five species are known as yet. They were collected at depths varying from 38 to 1539 fathoms, and at widely distant places, viz., in the Greenland Sea, between the Cape of Good Hope and Kerguelen Islands, off Australia, to the north of New Guinea, and off Japan; and as the different species of this genus form a very natural group, it is, I think, very probable, that later investigations will show also for interjacent places the occurrence of forms belonging to this same group. *Oorhynchus* is as yet the only genus which seems to inhabit depths exceeding 800 fathoms exclusively; but as only a single specimen of the one species known of this genus has been collected, I do not think it expedient to pay much attention to this fact.

Hence, with regard to the bathymetrical range, a close study of the material brought home by the Challenger, added to what was previously known on the subject, has shown:—

(1) That those genera which range most widely geographically are also those which range most widely in depth; and (2), that there does not seem to exist a single true deep-sea genus of Pycnogonids.[1]

As for the influence of the increasing depth on the form and the structure of our animals, this is by no means easily traced. As far as the structure of the integument and of the eyes is concerned, I will treat the question at some length when speaking of their structure. As a rule the true deep-sea species are more slender, the legs very long and brittle, and the surface of the body smooth, whereas the true shore-inhabitants are much more concentrated, have shorter legs, and are often densely covered with

[1] From the study of deep-sea forms in general, Mr Moseley and others came to the conclusion that these animals have a world-wide range. Of this the Pycnogonids give a fair instance, I believe (Moseley in Nature, April 8, 1880 p. 546).

hair. However, these rules admit of a great many exceptions. Thus the most common shallow-water species of the English, French, and Dutch coasts is *Nymphon gracile*, Leach, an exceedingly slender animal with very long legs, and moreover almost smooth. *Colossendeis proboscidea*, Sab., sp., is a blind species occurring only at a considerable depth; yet it has a highly concentrated body with short legs. Two species of *Phoxichilidium*, for which I have proposed the names *Phoxichilidium pilosum* and *Phoxichilidium mollissimum*, are true inhabitants of the depths of the ocean; yet they are not smooth at all, but covered by a very hairy integument. The case of *Phoxichilidium patagonicum* and its variety *elegans*, which I describe hereafter, must probably be considered as a trifling instance of the effect of depth on the slenderness of the body.

The scientific and trustworthy material at our disposal is by no means sufficient to enable us to discuss thoroughly the question of the geographical distribution of Pycnogonids. Judging from what is known of the European and North American coasts, it is most probable that on all coasts, and everywhere in shallow water in the neighbourhood of the shore, forms of Pycnogonids will be found occurring; and as I think it improbable that any true shore-inhabitant will be found which shows a very wide range, it is also highly probable that the number of littoral forms at present known is very small in comparison with the number really existing.

The distribution of those Pycnogonids which are not to be considered as shore-inhabitants, but which have never been dredged yet at depths exceeding 500 fathoms, is best known in the northern part of the Atlantic and the seas corresponding with it (North Sea, Greenland Sea, Barents Sea). The species of the genus *Nymphon*, which occur in the neighbourhood of the coast of New England, are found to the north and east as far as Greenland, Spitzbergen, and Novaja Semlja; but these Arctic Seas are, moreover, inhabited by some forms of the same genus occurring there only. As this point has been more fully discussed by me in another paper, it will suffice merely to mention it here.

Among the Pycnogonids of the Challenger Expedition, *Colossendeis megalonyx*, Hoek, is the only species, which, though found at a depth of from 55 to 120 fathoms, has a wide range; about the 58th south parallel it was dredged off Kerguelen Island, and also between Patagonia and the Falkland Isles.

With respect to the true deep-sea species the material is by no means sufficient for the study of their geographical range. Of the thirty-six species of Pycnogonids brought home by the Challenger, nineteen are true deep-sea species. Of these only three belong to the northern hemisphere, viz., *Colossendeis minuta*, Hoek, south of Halifax; *Phoxichilidium oscitans*, Hoek, west of the Azores; and *Phoxichilidium mollissimum*, Hoek, off Yeddo; they were only dredged once and were new to science. Of the remaining sixteen, which belong to the southern hemisphere, one was dredged at lat. 65° 42′ S. (*Nymphon meridionale*, Hoek) and one almost under the equator (*Nymphon per-*

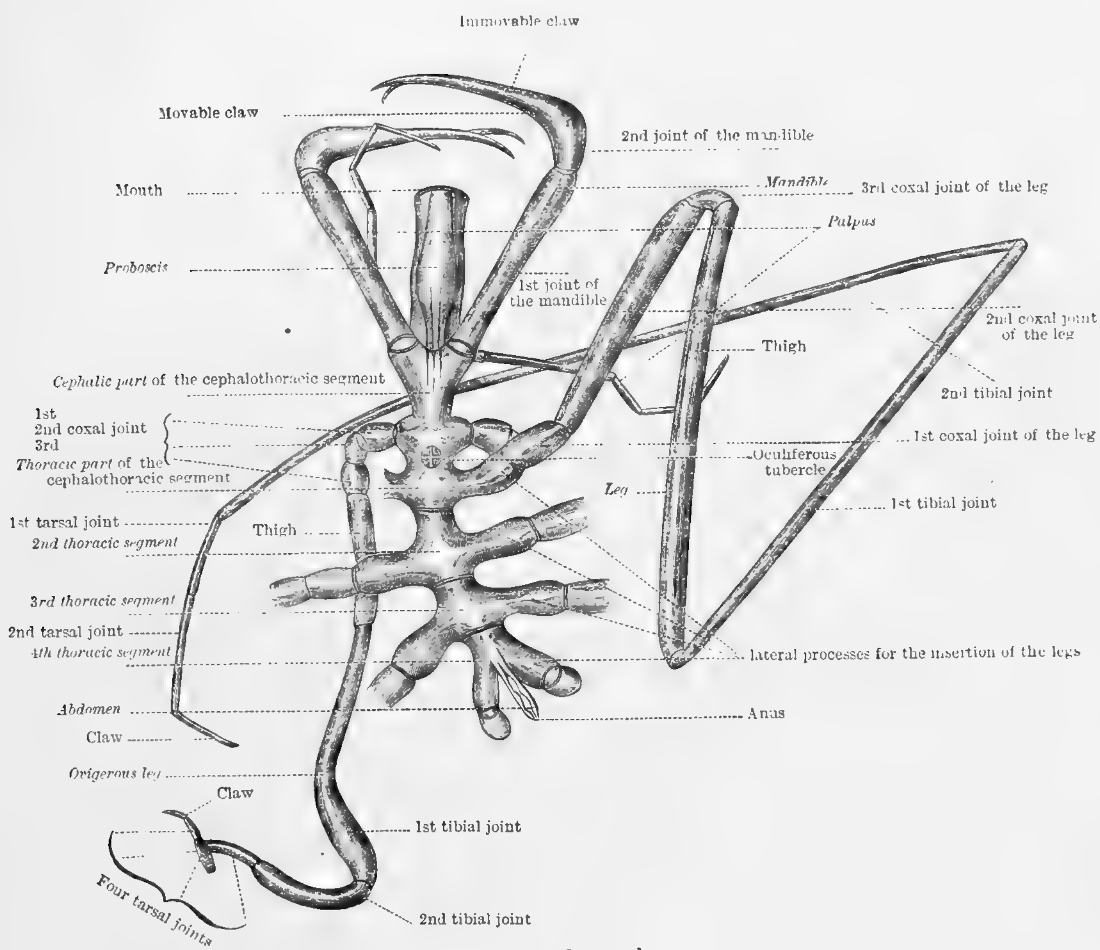
lucidum, Hoek, at lat. 0° 48′ S.). The fourteen remaining species were all dredged between lat. 33° 31′ S., and lat. 53° 55′ S. ; and it is a remarkable fact, that those two latitudes limit a zone of about 20°, in which Pycnogonids seem to be rather common. However, even in this zone they are again much localised, being almost in every instance from near the coast of an island or continent. For miles the dredge was let down without bringing up a single specimen ; whereas six species were found occurring at Stations 146 and 147, off the Crozets Islands (these Stations being very near to one another, I take as one) ; one at Station 157 ; three east of New Zealand, at Stations 168 and 169 ; five between Juan Fernandez and Valparaiso (Stations 298, 299, and 300) ; and two east of Buenos Ayres (Stations 320 and 325).

These facts indicate, I think, that the number of places inhabited by deep-sea Pycnogonids are not very numerous, and that where Pycnogonids do occur, many forms are, as a rule, found living together. This also ought to be observed when considering that between Stations 237 (off Yeddo) and 298 (between Juan Fernandez and Valparaiso), throughout a course of 11,775 miles, the dredge was let down sixty times and not a single Pycnogonid was obtained. This of course may partly be ascribed to the circumstance, that on an average the depth of that part of the ocean is too considerable to be inhabited by Pycnogonids ; but as the depth at many stations during that part of the voyage did not exceed the depths of other stations at which Pycnogonids were dredged, this cannot be considered as the only reason. Also when the same circumstance is found to be the case in that large part of the South Atlantic between the Azores and Station 146, where during a course of more than 9000 miles the dredge was let down at 76 stations without a single return of Pycnogonids, and this although the depth at these stations is less, and at most of them much less, than some of the greater depths at which Pycnogonids were found, it is quite evident that the depth of the sea alone cannot be held responsible for it. Nor do I consider it yet proved that Pycnogonids are totally wanting in these oceans, as only a very small area of these oceanic abysses has been explored ; so I think the only conclusion which at present may be drawn is this, that as yet only a few of the places where Pycnogonids occur in great numbers have been found out.

In regard to the nature of the bottom from which the Pycnogonids of the Challenger Expedition were obtained, conclusions must be also somewhat uncertain. The bottoms on which they occur seem to be extremely different. We find that one species was brought up from a bottom of gravel and stones, one from hard ground, one from rocky ground, five species are recorded as having been brought up from a muddy bottom, one from diatom ooze, five from a sandy bottom, three from a bottom of grey ooze, three from grey mud, and three from globigerina ooze. The other species were obtained from rocky bottoms in the neighbourhood of the shore.

More particulars about the geographical and bathymetrical distribution of the

Pycnogonids may be found in the list of the species hitherto described, which I append to this report. I have tried to make it as complete as possible; yet it contains many species of which no information is given as to the depth at which they were found; others of which even the locality they inhabit is not accurately stated; and futhermore, there are genera and species—and of the latter no small number—about which we are totally left in the dark. To explain this the reader must keep in mind (1) that this is the first



Nymphon, sp.[1]

attempt to make such a list, with the exception of a very incomplete and superficial enumeration published in 1874 by Semper,[2] and (2) that there is as yet no paper published which discusses the relative value of distinguishing marks. So it is evident that the making of this list has been an exceedingly troublesome affair, and that some allowance may be made for its incompleteness.

[1] For reasons easily to be understood I have taken a species of *Nymphon* as the type.

[2] C. Semper, Ueber Pycnogoniden und ihre in Hydroid-Polypen schmarotzenden Jugendformen. Arbeiten des Zool. Zoot. Instituts in Würzburg, Band i., 1874.

Before inserting this list I wish to give a short description of the body of a Pycnogonid, and at the same time to state the nomenclature I have made use of.

The body of every Pycnogonid consists of four segments, the first of which is to be considered as formed by the connection of the head with the first thoracic segment. At the anterior end this first segment is furnished with a long and stout proboscis. This proboscis is situated either about the front of the first segment, as in *Nymphon*, and in this case is capable of very limited motion, or as in *Ammothea* and *Ascorhynchus*, though also situated about the front, it is connected with the segment by means of an articulation, and for that reason is highly movable, or it is, as in *Phoxichilidium*, situated on the ventral surface of the first segment, and bent forward; or finally, it is situated about the ventral side, and at the same time lapped over it (*Böhmia*, mihi). The form and size of this proboscis varies greatly. At its extremity it is furnished with a triangular mouth. It is to be considered as an unpaired outgrowth of the region surrounding the mouth, and has nothing to do with a true head, as was supposed by Savigny. Neither is there anatomically or embryologically any real ground for the opinion, suggested by Huxley,[1] that the proboscis represents the united cheliceræ and pedipalpi like that of Acarina.[2]

The cephalic part of the cephalothoracic segment is generally furnished with three pair of appendages, which long ago received the names of mandibles, palpi, and ovigerous legs. As far as has been ascertained till now, there is not a single genus of Pycnogonid, which does not show these three pair of appendages either in the adult state, or during its embryological development. Yet cases are not rare, in which in the adult animal, either the first (the mandibles) or the second pair (the palpi) or both are deficient. With respect to the third pair of appendages (the so-called ovigerous legs), on the contrary, they are never found wanting, as far as we know, in the adult animal of either sex. Whoever studies different forms of Pycnogonids, will soon discover what a difference may be caused in the appearance of the cephalic part of the body by the presence or absence of the cephalic appendages; hence it is that the various authors who have proposed a classification of the group have largely made use of this presence or absence of cephalic appendages. Although there is no doubt, I believe, that good characteristics may be derived from the number of these appendages, the following may show how extremely necessary it is to be cautious in this matter.

[1] Huxley, Anatomy of Invertebrated Animals, p. 386, London, 1877.

[2] On a tranverse section, the proboscis of the Pycnogonids always shows a more or less distinctly triangular shape, the mouth is also triangular, &c. The total form, therefore, is to be compared with the fruit of a monocotyledonous plant, composed of three carpels. Of these one is placed dorsally, the two others meet longitudinally in the middle of the ventral side. If anybody should feel inclined to try again to homologise the proboscis with cephalic appendages, he will have to call the dorsal piece the labrum, and the two others the homologues of mandibles. However, in the earliest stages of development I have observed, the proboscis has already the form of a short cylindrical appendage, and I must point out the anatomical fact that the proboscis for the greater part is innervated from the supraœsophageal ganglion.

The mandibles in some genera are two-jointed (*Nymphon*, *Pallene*, &c.), in others three-jointed (*Phoxichilidium*). As a rule the second or third joint terminates in a pair of pincers, with a movable and an immovable claw. Now there are genera, some species of which show the mandibles small, yet furnished with true pincers, whereas other species of the same genus show the mandibles in a much more rudimentary state, as if, for instance, represented only by a single joint terminating abruptly (*Ascorhynchus glaber*, Hoek, and *A. minutus*, Hoek). In other genera the mandibles are in the adult animal always rudimentary, represented only by short stumps (*Lecithorhynchus*, Böhm, *Oorhynchus*, Hoek, &c.); whereas in a fourth category the mandibles have totally disappeared (*Colossendeis*, *Phoxichilus*, *Pycnogonum*, &c.). Among the specimens of a species of one of these genera (*Colossendeis gracilis*, Hoek), dredged during the cruise of H.M.S. Challenger, I have, however, found one specimen furnished with a pair of distinctly three-jointed mandibles, terminating in a pair of pincers; and this specimen was the largest of the three obtained.

The palpi when present show very different numbers of joints. Thus there are only three in *Pephredo*, five in *Nymphon* and *Discoarachne*, eight in *Achelia*, nine in *Ammothea* and *Corniger*, ten in *Ascorhynchus*, *Colossendeis*, &c. The palpi have disappeared in the genera *Pallene*, *Phoxichilidium*, *Phoxichilus*, *Pycnogonum*, &c. In *Phoxichilidium* they are as a rule still represented by rounded lateral processes placed at both sides of the front part of the cephalothorax, whereas Böhm has observed a specimen of *Pallene* furnished with rudimentary, yet distinct two-jointed palpi.

The third pair of appendages, viz., the ovigerous legs, are never wanting in any species of Pycnogonids. Among the Pycnogonids of the Challenger, there is not even a single specimen without ovigerous legs! As a rule they are ten-jointed; the first three joints are extremely small, the two following are the longest of all, the sixth joint is a great deal shorter, the last four joints are much shorter still, the tenth joint as a rule is furnished with a claw. In some genera (*Colossendeis*, *e.g.*) the fifth joint is small, the sixth as long as the fourth joint. In those genera, where a certain tendency is observed to drop their cephalic appendages, the ovigerous legs share this fate only to a small extent. As the functions of the ovigerous legs are twofold, one being to bear the eggs, a function only accomplished by the male,[1] the other to serve as an organ of feeling, also, in all probability, of seizing the food, and as the latter of these functions is almost identical with that of the other cephalic appendages, it is quite natural, I believe, that, whereas the males are never seen without these appendages, they are wanting in the females only of those genera which have also lost their other cephalic appendages. Finally, it is evident, that the males of those latter genera ought to show the ovigerous legs in such a rudimentary state, as to be fit only for the ovigerous function.

Dorsally the front part of the cephalothorax bears the oculiferous tubercle; although

[1] Hereafter I will show that this rule admits of an exception. See under *Nymphon brevicaudatum*, Miers.

in many instances—especially in the true deep-sea species—the eyes are wanting (a matter to be discussed hereafter), it never happens that the tubercle has totally disappeared. Most genera have this tubercle placed nearly in the middle between the two ovigerous legs; but in some genera (*Phoxichilidium, e.g.*) it is situated much nearer the front of the segment.

The thoracic part of the cephalothorax and the three following true thoracic segments are furnished with lateral processes for the insertion of the legs; these lateral processes in the different genera, and even in different species of the same genus, are of very different lengths. The segments of the body themselves are also of very different lengths. There are extremely slender forms with long segments and widely separated lateral processes, and there are also forms so highly concentrated, that the lateral processes are not separated at all; and between these extremes, which are often met with in one and the same genus, numerous intermediate forms are to be observed. The dorsal surface of the body is either smooth or furnished with knots, spines, strong prickles, &c.

At its extremity, between the two lateral processes for the insertion of the last pair of legs, the last thoracic segment has a rudimentary abdomen of varying length, which is sometimes (*Colossendeis, e.g.*) connected with the segment by means of an articulation, and also sometimes (*Zetes*, Kröyer) shows traces of being divided into two segments.[1] At its extremity the anal aperture is found.

The legs begin at the ends of the lateral processes; they are eight-jointed. For the joints I retain the names proposed by Johnston; these names are the same as those used in entomology, but it is evident that in this case identity of name does not necessarily go along with identity of meaning; neither analogical nor homological comparison is meant by it.

The first three (the coxal) joints are as a rule very short; the following three, the thigh and the two tibial joints, are much longer (the second tibial being in most cases the longest of all). The two tarsal joints are again a great deal shorter. The first tarsal as a rule is shorter than the second; in many instances it is even extremely small, its function then being only to furnish a highly movable articulation to the last joint of the leg. At its extremity the last joint is furnished with a claw, which is, or is not, accompanied by two accessory claws.[2] In some genera (*Colossendeis, e.g.*) accessory claws are never observed, while in other genera (*Nymphon*) they occur in some species and are wanting in others. Therefore the presence or absence of accessory claws alone should not be made use of in establishing new genera.

[1] *Rhynchothorax mediterraneus*, Cos., Microdoride mediterranea, Napoli, 1861, has a seven-jointed abdomen (Addome angusto e brevissimo di 7 articoli).

[2] I think there is not a single reason for calling this claw a ninth joint. At any rate the homology of the claw with its accessory claws is much greater than that between the claw and the joints of the leg, and, therefore, if the claw is considered as a ninth joint in those cases where accessory claws are observed, we must speak of a joint having two lateral joints close to its origin, which would be absurd.

Catalogue of the Species of Pycnogonida at present known, with Indications of the Habitat and Range in Depth of each Species.

A point of interrogation has been placed before uncertain or not sufficiently determined species, and an asterisk before those dredged by the Challenger Expedition, and during the cruise of the "Knight Errant"; of these a full description is given hereafter. In the left-hand column the range in depth of each species is given.

Class PYCNOGONIDA, Latr.

Crustacea haustellata, Johnston; *Crustacês araneïformes* M.-Edw.; *Podosomata*, Leach; *Pantopoda*, Gerstæcker.

Family I. Nymphonidæ

Contains those Pycnogonida which have both mandibles and palpi strongly developed. The ovigerous legs are always present in both sexes, and are, as a rule, furnished with denticulate spines. The only genus: *Nymphon*.

Depth in Fathoms.	Name.	Geographical Distribution.
	Nymphon. Fabr. (1794) Mandibles biarticulate, cheliform; palpi, five-jointed; ovigerous legs, ten-jointed.	
	A. Species with auxiliary claws.	
10 to 15 (Miers). 33 (Bell). 48 to 50 (Wilson). 52 (U. S. Fish. Com.). 299 (Sars).	*Nymphon hirtipes*, Bell, Belcher, The Last of the Arctic Voyages, vol. ii. p. 408, 1855. Prof. G. O. Sars (1877) considers this species to be the same as *N. hirtum*, Fabr., which in that case would not be identical with *N. hirtum*, Fabr., as described by Kröyer (1845). As it is impossible to recognise the species by the description of Fabricius, I think it safest to retain the name *N. hirtum* for the species of Kröyer whose description was published long before Sars' Prodromus. *N. hirtum*, Fabr., Sars, in Prodromus descriptionis, &c. (Arch. für Math. og Nat., ii. 1877). *N. hirtipes*, Bell, Wilson, Pycnogonida of New England, Trans. Connect. Acad., vol. v., 1880. Having received from the U. S. Fish. Commission a specimen brought up off Halifax, I feel certain that the animal described by Wilson belongs to this species. Finally, I believe that the specimens studied by Miers, and referred by him to *N. hirtum* (Arctic Crustacea in Ann. and Mag. Nat. Hist., 4th series, xx. 108, 1877) belong to this species and not to *N. hirtum*, Fabr. The *N. hirtum*, var. *obtusidigitum*, Miers, seems to be an undeveloped female of the same species.	Lat. 64° 36′, long. 10° 21′ 5″. Off Halifax; Franklin-Pierce Bay; Discovery Bay; Flœberg Beach; Northumberland Sound. "Appears to be a common inhabitant of the high northern latitudes" (Miers). (A common species at different stations in the Barents Sea. Hoek, in MS.)

Depth in Fathoms.	Name.	Geographical Distribution.
80 to 90	*Nymphon pallenoides*, G. O. Sars, Crustacea et Pycnogonida nova, Arch. f. Math. og Naturvid., iv., 1879, p. 470. Of this species Sars says that it is *N. hirsuto* affine, sed statura minore, &c. Perhaps it is only a local variety. As Sars does not mention the length of the auxiliary claws, I feel uncertain whether it is nearest to *N. hirtipes*, Bell, or *N. hirtum*, Fabr. (Kröyer).	Coast of Norway (Saltenfjord).
	Nymphon hirtum, Fabr. Entom. Systematica, iv. 417, 1794. *N. hirtum*, Chr. Fabr. (?), Kröyer, Bidrag, &c., Nat. Tidskr., N. R. i. 113, 1845. The description of Fabricius being quite insufficient, I retain the species with the diagnosis of Kröyer. Perhaps *N. hirsutus*, Sabine (Appendix, &c., p. ccxxvi, 1824), belongs also to this species; according to Kröyer this is doubtful. *N. hirtum*, O. F. Buchholz, Crustaceen der Zweiten Deutschen Nordpolarfahrt, 1874, ii. 397. In regard to *N. hirtum*, Fabr. Heller (Crust., Pycnogon., und Tunicaten der K. K. Ost.-Ung. Nordpol. Exp. in Denkschr. d. Kais. Akad. d. Wiss., Bd. xxxv., 1875), it is impossible to determine whether it is this species or *N. hirtipes*, Bell, that was observed.	Norwegian Ocean, Iceland, East Coast of Greenland (Böhm, Pycnogoniden des Museums zu Berlin, 1879); East Coast of Greenland (Nordshannan), Storfjord (Spitzbergen), Buchholz, *loc. cit.*
15 to 65 (Böhm). 25 to 120 (Challenger).	**Nymphon brevicaudatum*, Miers, Ann. and Mag. of Nat. Hist., 4th series, vol. xvi. p. 117, 1875). Crustacea of Kerguelen Island, Phil. Trans. Lond. vol. clxviii. Extra vol., pp. 200–214, 1879, pl. xi. fig. 8. *N. horridum*, Böhm, Pycnogoniden des Museums zu Berlin, Monatsber, der Königl. Acad. d. Wiss. zu Berlin, 1879, p. 175, taf. i. fig. 3–3*f*. Böhm's supposition that his *N. horridum* was indentical with Miers' *N. brevicaudatum* is true, as has been proved by the more extensive description with illustrations published by Miers in 1879 in the extra vol. of the Phil. Trans. of London. Many specimens of this species were obtained during the visit of H.M.S. Challenger to Kerguelen.	Kerguelen.
10 to 80 (Miers). 35 to 90 (Wilson). 515 to 540 ("Knight-Errant"). 110 to 160 (Barents Sea, Hoek in MS.).	**Nymphon strömii*, Kr., Nat. Tidskr., N. R., vol. i. p. 111, 1845. Wilson (Pycnogonida of New England, Trans. Connect. Acad., vol. v. p. 17, 1880) believes that the *N. gracilipes*, Heller (Crust. Pycnog. und Tunic. des K. K. Oester.-Ungar. Exped. Denkschr. d. K. Ak. der Wiss., xxxvi., 1875)—not to be confounded with the *N. gracilipes*, Miers, and therefore named by Böhm (Pycnogoniden des Museums zu Berlin, Monatsb. der K. A. d. Wiss. zu Berlin, p. 170, 1879) *N. Helleri*—is very closely allied if it is not identical with this species. This is also my opinion, although Heller in his	Coast of Norway? (Kröyer), North Atlantic (Sars and "Knight Errant" cruise), Barents Sea (Hoek in MS.), "An verschiedenen Punkten" (Heller, *i.e.*, during the Austria-Ungarian North Polar Exped. of 1873); Flœberg Beach, Cape Fraser, Grinnelland (Miers), Coast of North America, Gulf of St Lawrence,

Depth in Fathoms.	Name.	Geographical Distribution.
	diagnosis of his species says : unguiculi auxiliares nulli (p. 40). A considerable number of specimens of this species have recently been dredged (North of Scotland) during the cruise of the "Knight Errant." One of the commonest species in the northern part of the Atlantic.	off the Isles of Shoals, off Halifax (Wilson).
(?)	(?) *Nymphon giganteum*, Goodsir, Ann. and Mag. of Nat. Hist., vol. xv. p. 293, 1845. Goodsir's description is not sufficient to determine this species. Wilson (Pycnogonida of New England, Trans. Connect. Acad., vol. v. p. 16, 1880) considers this species as identical with the *N. strömii* of Kröyer. As Goodsir does not even say whether the body is slender or robust, it is extremely difficult to ascertain whether or not Wilson's suggestion is right.	Sea at Embleton, Northumberland.
412 540 ("Knight Errant")	**Nymphon macronyx*, G. O. Sars, Prodromus, Arch. f. Math. og Naturvid., ii. 365, 1877. I know this species by the description of Prof. Sars, from a pencil-drawing he kindly sent me, and feel sure it is a good species. Recently I had a fair opportunity of becoming acquainted with it, as numerous specimens were dredged north of Scotland, and forwarded to me by Mr Murray. As only a very short diagnosis of this species has been given by Prof. Sars, I will publish hereafter a detailed description of it.	Lat. 62° 44′ 5″ N., long. 1° 48′ E. To the north of Scotland.
83	**Nymphon brevicollum*, n. sp. A fine, well-characterised species.	South of Halifax, Station 49, Challenger Expedition.
45 to 120	**Nymphon brachyrhynchus*, n. sp. A small but well-characterised species, which seems to abound at a depth of 45 to 120 fathoms.	Kerguelen.
1675	**Nymphon meridionale*, n. sp., shows a certain affinity to *N. gracilipes*, Miers (Ann. and Mag. of Nat. Hist., 4th ser., vol. xvi. p. 76, 1875); so the latter species may be considered as a shore-relation of this true deep-sea species.	South of Kerguelen Island, lat. 65° 42′ S., long. 79° 49′ E., Station 43, Challenger Expedition.
10 to 45	*Nymphon gracilipes*, Miers, Ann. and Mag. of Nat. Hist., 4th series, vol. xvi. p. 76, 1875. *N. gracilipes*, Miers, Böhm, Pycn. des Mus. zu Berlin, Monatsb. der K. Akad. der Wiss. zu Berlin, p. 170, 1879. *N. antarcticum*, Miers, Crustacea of Kerguelen Island, Phil. Trans. Lond., vol. clxviii. Extra vol., p. 200–214, pl. xi., 1879. This species seems to be a good species. Miers thought it necessary to alter the name he originally proposed, because in the same year the same name was given by Heller to an arctic species. The *N. gracilipes*, Heller, being only a synonym of the *N. strömii*, Kr., I think it best to retain this name for the Kerguelen species, as was originally proposed by Mr Miers.	Kerguelen.

Depth in Fathoms.	Name.	Geographical Distribution.
120	**Nymphon fuscum*, n. sp. This species too seems to be closely allied to *N. gracilipes*, Miers.	Kerguelen.
2225	**Nymphon longicollum*, n. sp. The only specimen of this true deep-sea species shows very characteristic features.	Off Coast of Chili (Station 298, Challenger Expedition).
1 to 2	*Nymphon gracile*, Leach, Zool. Misc., vol., i. p. 45, 1814. *N. gracile*, Leach, Johnston, An Attempt, &c., in Mag. of Zool., 1837. *N. gracile*, Leach, Hoek, Ueber Pycnogoniden, Nied. Arch. f. Zool., iii., 1877. It has been suggested by Kröyer that it might be the same as N. *grossipes*, O. Fabr., but I prefer to retain the name of Leach for the species as known by the description and figures of Mr Johnston and myself, which is distinct from *N. grossipes*, O. Fabr., as described by Kröyer.	British Seas everywhere (Leach), Dutch Coast (Texel) (Hoek).
229 ; 417	*Nymphon megalops*, G. O. Sars (Prodromus descriptionis, &c., Arch. f. Math. og Naturvid., ii. 366, 1877). Not figured. Prof. Sars kindly sent me a pencil-drawing, and from this drawing and his Latin diagnosis I believe the species is nearly related to *N. gracilipes*, Miers.	Lat. 63° 10′ 2″ N., long. 4° 59′ 6″ E. Lat. 64° 36′ N., long. 10° 21′ 5″ E.
825	**Nymphon perlucidum*, n. sp. A very well-characterised species, of which, unfortunately, only one specimen was dredged by the Challenger.	Between Celebes and Halmahera.
60 (Wilson) 220 (Sars) 67 (Hoek in MS.).	*Nymphon longitarse*, Kr., Bidrag till Kundskab, Natur. Tidskr. N. R., i. 112, 1845, is so nearly related to *N. mixtum*, Kr., that it may, perhaps, be only a variety of that species, andin that case, of course, of *N. grossipes*, O. Fabr.; however Wilson (Pycnogonida of New England, Trans. Connect. Acad., vol. v. p. 19, 1880) believes it a good species, readily distinguished by its extremely attenuated appearance. From the Barents Sea I got some specimens, which unquestionably belong to the form described by Kröyer.	Coast of Greenland and West Norway; off Halifax, St George's Banks, lat. 61° 47′ 2″ N., long. 3° 18′ 5″ E. Barents Sea (Hoek in MS.).
Shore; "majores etiam in profundo" (Oth. Fabr. Fauna Groenl) 50,20 to 100 (Wilson) 83 (Challenger). 540 ("Knight Errant".	**Nymphon grossipes*, Oth. Fabr. (sp.), 1780. *Pycnogonum grossipes*, Oth. Fabr., Fauna Groenlandica, p. 229, 1780. (?) *Phalangium grossipes*, Linn., Syst. Naturæ, xii. 1027, 1766 (?). (?) *Nymphon grossipes*, Fabr., Entom. System. emendata et aucta, tom. iv. p. 417, 1794 (?). *N. grossipes*, Oth. Fabr., Kröyer, Bidrag till Kundskab, Nat. Tidskr., N. R., i. 108, 1845. *N. grossipes*, Oth. Fabr., Wilson, Pycnogon. of New England, Trans. Connect. Acad., v. 21, 1880. The species is best known from the descriptions of Kröyer and Wilson. Three specimens were obtained during the Challenger Expedition, and a single	North Sea (Böhm, Pycnogoniden des Museums zu Berlin, Monatsber. der K. Akad. d. Wiss. zu Berlin, 1879); Coast of Norway (Kröyer), Barents Sea (Hoek in MS.), Northern part of the North Atlantic ("Knight Errant," 1880); East Coast of Greenland (Fabricius, Buchholz); North Georgian Islands (Sabine, Suppl. to the Ap-

Depth in Fathoms.	Name.	Geographical Distribution.
	one during the cruise of the "Knight Errant" north of Scotland.	pendix, &c., p. ccxxv. 1824); Coast of North America, from the Gulf of St Lawrence, as far south as Long Island Sound (Wilson), Challenger Exped., Station 49, South of Halifax, U. S. A.
417 (Sars).	(?) *Nymphon mixtum*, Kr., Nat. Tidskr. N. R., i. p. 100. 1845. *N. mixtum*, Kr., Buchholz, Zweite Deutsche Nordpolarfahrt, Crust., p. 397, 1874. *N. mixtum*, Kr., G. O. Sars, Prodromus (Archiv. f. Math. og Naturvid., ii. 366, 1877) = *N. grossipes*, O. Fabr., Wilson, Pycnogonida of New England, Trans. Connect. Acad., vol. v. p. 20, 1880. Wilson thinks the *N. mixtum*, Kr., is undoubtedly a form of *N. grossipes*, O. Fabr. I also believe it so nearly related to *N. grossipes*, that it may be only a variety. Buchholz writes (*loc. cit.*, p. 397) :—"Doch muss ich es dahingestellt sein lassen, ob die von Kröyer angegebene auf dem Verhältniss der Länge des Tarsus zum Endglied beruhende Artunterscheidung ausreichend ist, um diese Art von der vorigen (*N. grossipes*, O. Fabr.) zu trennen."	Coast of West Norway (Kröyer), lat. 63° 10′ 2″ W., long. 4° 59′ 6″ E. (Sars); East Coast of Greenland, Spitzbergen (Buchholz, *loc cit.*).
(?)	(?) *Nymphon brevitarse*, Kr., Nat. Tidskr. N. R., i. 115, 1845. *N. hirsutum*, Kr., Grönlands Amfipoder, p. 92, 1838 (Autoritate, Kröyer) = *N. grossipes*, O. Fabr., Wilson, Pycnogonida of New England, Trans. Connect. Acad., p. v. 20, 1880. In all probability Wilson is right when he says *N. brevitarse* is only a form of *N. grossipes*.	Coast of Greenland.
160 (Hoek in MS).	*Nymphon sluiterii*, Hoek, in MS., Pycnogonids of the first two cruises of the W. Barents. A well-characterised arctic species, with extremely small auxiliary claws, second joint of the palpus longer than third, first tarsal joint longer than second, with a claw at the end of the legs, which is not shorter than the last joint of the leg, and a truncate oculiferous tubercle.	Barents Sea (Hoek in MS.).
146 to 180 (G. O. Sars). 160 (Hoek in MS.).	*Nymphon serratum* G. O. Sars, Crustacea et Pycnogonida nova, Arch. f. Math. og Naturvid., iv., 471, 1879. An extremely characteristic species, with a large spine dorsally on the first three segments of the trunk.	South of Spitzbergen, Barents Sea (Hoek in MS.).
(?) 25 to 35	(?) *Nymphon brevirostris*, Hodge, Mennell, Report on Dredging off the Northumberland Coast and Doggerbank, British Association Report, p. 119, 1862. A very unsatisfactorily described species; in all probability the same as *N. brevitarse*, Kr. = *N. grossipes* O. Fabr.	(?) Northumberland Coast, Doggerbank.

Depth in Fathoms.	Name.	Geographical Distribution.
(?)	(?) *Nymphon glaciale*, Lilljeb., *N. glaciale*, Lilljeb., Jarzynsky, Præmissus Catalogus Pycnogonidarum in mari glaciali, Annales de la Société des Naturalistes de St Petersbourg, 1870. I have never seen a specimen of it, nor do I know where the description of Lilljeborg is to be found.	White Sea.
(?)	(?) *Nymphon femoratum*, Leach, Zool. Misc., i. 45, pl. xix. fig. 2, 1814. *N. femoratum*, Leach, Milne-Edwards, Hist. Nat. des Crustacés, iii. 534, 1840. *N. femoratum*, Leach, Johnston, An Attempt &c., Mag. of Zool. and Botany, i., 1837. In all probability not a good species: description very insufficient; dilated thighs are common to the females of almost all the species.	Channel.
(?)	(?) *Nymphon pellucidum*, Goodsir, Edin. New Phil. Journ., vol. xxxii., 1842. Characterised very insufficiently: may turn out to be a variety of *N. brevitarse*, Kr.	Coast of England.
(?)	(?) *Nymphon spinosum*, Goodsir, Edin. New Phil. Journal, vol. xxxii., 1842. Like the other species of Goodsir, *N. spinosum* has been described so very insufficiently that it is not to be recognised.	Coast of England.
(?)	(?) *Nymphon johnstonii*, Goodsir, Edin. New Phil. Journal, vol. xxxii., 1842. A very uncertain species.	Coast of England.
(?)	(?) *Nymphon minutum*, Goodsir, Edin. New Phil. Journal, vol. xxxii., 1842. Goodsir's description is so insufficient that the species is not to be recognised.	Coast of England.
(?)	(?) *Nymphon longiceps*, Grube, 46ster Jahres-Ber. der Schles. Gesellsch. f. vaterl. Cult. p. 54, 1869. The description of this species is so insufficient that it is impossible to recognise it.	China Sea.
	B. Species without auxiliary claws.	
480 (Station 56, "Porcupine"), 412 : 299 (Sars). 375, 540 ("Knight Errant"). 120 to 160 (Barents Sea, Hoek in MS.).	**Nymphon robustum*, Bell, Belcher's Last of the Arctic Voyages, vol. ii. p. 409, 1855, Tab. xxxv. fig. 4 = *N. hians*, Heller, Crust, Pycnog. und Tunicaten der K. K. Oester. Ungar. Nordpol. Exped., Denkschr, d. Wiener Akad. xxxv. p. 41, 1875, = *N. abyssorum*, Norm., Wyville Thomson, Depths of the Sea, p. 129, 1873. I quite agree with G. O. Sars (Prodromus, Arch. for Math. og Naturvid., ii. 365, 1877), who places *N. hians*, Heller, and *N. abyssorum*, Norman, as identical with this species. A large and excellent species abounding in the higher northern latitudes. The largest haul of Pycnogonids, Mr Murray writes to me, he ever saw was that in which he got an immense number of specimens of this species (Cruise of the "Knight Errant" to the north of Scotland, Aug. 1880).	60° 2', 62° 44' 5", 64° 36' N. lat.; 6° 11,' 1° 26' W. long., 1° 48' E. long. Barents Sea (Hoek in MS.). North of Scotland.

Depth in Fathoms.	Name.	Geographical Distribution.
1100	**Nymphon compactum*, n. sp. A well-characterised deep-sea species, of which only females—two specimens in all—have been dredged.	East of Auckland (Station 128, Challenger Expedition).
50	*Nymphon phasmatodes*, Böhm, Pycnogoniden des Museums zu Berlin, Monatsb. der K. Akad. der Wiss. zu Berlin, p. 173, 1879, Taf. i. fig. 2–2*b*. Seems to be a good species.	Cape of Good Hope.
1375 to 1600	**Nymphon hamatum*, n. sp. A good and common deep-sea species.	Between Kerguelen and Cape of Good Hope.
1100	**Nymphon longicoxa*, n. sp. A fine well-characterised deep-sea species, of which thirteen specimens were dredged by the Challenger.	East of Auckland (Station 168, Challenger Expedition).
2160	**Nymphon procerum*, n. sp. A slender deep-sea species, which is well-characterised, yet requires further study.	West of Valparaiso (Station 299, Challenger Expedition).

Family II. Colossendeidæ

Contains those Pycnogonida which have either rudimentary mandibles or no mandibles at all, strongly-developed palpi and ovigerous legs present in both sexes, and as a rule furnished with denticulate spines. The genera belonging to this group are very numerous: *Ammothea*, *Ascorhynchus*, *Achelia*, and *Colossendeis* are typical representatives.

Depth in Fathoms.	Name.	Geographical Distribution.
	Ammothea, Leach (1815). Mandibles biarticulate, cheliform, feeble; palpi nine-jointed; ovigerous legs ten-jointed; proboscis pyriform.	
(?)	*Ammothea carolinensis*, Leach, Zool. Misc., vol. i. p. 34, 1815, pl. xiii. Of this species a very good drawing has been published by Leach.	South Carolina.
0 to 5	*Ammothea pycnogonoides*, Quatrefages, Mémoire sur l'organisation des Pycnogonides, Ann. d. Sc. Nat. 3ième série, Zool., tom. iv., Paris, 1845. I think this species is closely related to *A. longipes*, Hodge, but the descriptions of both authors are so very insufficient that this is not to be made out.	Saint Malo (Coast of France).
(?)	*Ammothea longipes*, Hodge, Ann. and Mag., 3d series, vol. xiii. p. 114, 1864; Grube, Verhandl. d. Schles. Gesellsch. f. vat. Cultur., 1869–72. The description of this species is also quite insufficient; it cannot be made out whether the species described by Grube is identical with that of Hodge. The specimen of Grube is furnished with six-jointed palpi, whence I believe it not to have been an adult animal. In all probability it is the same as that described by Quatrefages as *A. pycnogonoides*, Ann. d. Sc. Nat., iii. série, Zool., tom., iv., 1845.	Polperro (English Coast) (St Vaast la Hougue (Grube); Roscoff (Grube).

Depth in Fathoms.	Name.	Geographical Distribution.
(?) (Deep-water).	*Ammothea brevipes*, Hodge, List of the British Pycnogonoidea, with descriptions of several new species, Ann. and Mag. of Nat. Hist., 3d series, xiii. 113, 1864. Very insufficiently described.	Durham Coast; Heligoland (Semper).
(?)	*Ammothea achelioides*, Wilson, Transact. Connect. Acad., vol. v. part 1, p. 16, 1880. "In general appearance it is closely similar to *Achelia spinosa*, Stimpson" (Wilson, *loc. cit.*). No doubt there is a near relation between the genera *Achelia* and *Ammothea*, yet a minute examination of "adult" specimens of both genera makes it necessary to consider these genera provisionally as distinct.	Bay of Fundy (U S. A.).
	Böhmia, Hoek (1880).	
	Mandibles two-jointed, cheliform; palpi seven-jointed; ovigerous legs ten-jointed; proboscis conical, entirely bent over to the ventral side.	
(?)	*Böhmia chelata*, Böhm, sp.; *Pycnogonum chelatum*, Böhm. Pycnogoniden des Museums zu Berlin, Monatsb. der K. Akad. der Wiss. zu Berlin, 1879, p. 192 (pl. ii. fig. 5–5*d*). As the specimen observed by Böhm is furnished with ten-jointed ovigerous legs, I think there is not a single reason to consider it as a *Pycnogonum* in the larval condition. I therefore propose to form a new genus for it, and to call it after Mr Böhm.	(?)
	Phanodemus, Costa (1836).	
	Mandibles cheliform; palpi three- or four-jointed; ovigerous legs (?); proboscis conical.	
(?)	*Phanodemus horridus*, Costa, Fauna del regno di Napoli, Crostacei et Aracnidi, Napoli, 1838, p. 8. Description of this species extremely insufficient.	Gulf of Taranto.
(?)	*Phanodemus collaris*, Costa, Fauna del regno di Napoli, Crostacei et Aracnidi, Napoli, 1838, p. 8. Also described insufficiently.	Gulf of Taranto, Gulf of Naples.
(?)	*Phanodemus inermis*, Costa, Fauna del regno di Napoli, Crostacei et Aracnidi, Napoli, 1838, p. 9. Description not better than those of the foregoing species.	Gulf of Taranto, Gulf of Naples.
	Rhynchothorax, Costa (1861).	
	Mandibles cheliform, four-jointed; palpi eight-jointed; ovigerous legs (?); proboscis long-ovate.	
(?)	(?) *Rhynchothorax mediterraneus*, Cos., Microdoride mediterranea, Napoli, 1861, p. 8, Taf. i. fig. 102. A very curious animal, with a short and narrow abdomen of seven joints. The description, however, is insufficient.	North Coast of Africa.

Depth in Fathoms.	Name.	Geographical Distribution.
	Pephredo, Goodsir (1842).	
	Mandibles cheliform; palpi three-jointed; ovigerous legs six-jointed; proboscis short, cylindrical.	
(?)	*Pephredo hirsuta*, Goodsir, Edin. New Phil. Journal, 1842, vol. xxxii. p. 136. The description of this species as given by Goodsir is very insufficient.	Coast of England.
	Platychelus, Costa (1861).	
	Mandibles cheliform; palpi five-jointed; ovigerous legs (?); proboscis pyriform.	
(?)	*Platychelus sardonicus*, Costa, Microdoride mediterranea, Napoli, 1861, p. 11. The description of the genus and species is given from a single specimen, and this has been most probably an immature female.	Coast of Sardinia.
	Oiceobathes, Hesse (1867).	
	Mandibles small, three-jointed, cheliform; palpi eight-jointed; ovigerous legs (?); proboscis conical.	
(?)	(?) *Oiceobathes arachne*, Hesse, Ann. d. Sc. Natur., 5ième série, vii. 201, 1867. Description quite insufficient. Perhaps the genus *Oiceobathes* is the same as *Ammothea*.	Coast of France (Brest).
	Ascorhynchus, G. O. Sars (1877).	
	Mandibles rudimentary, cheliform or not cheliform; proboscis pyriform, more or less bent over to the ventral side; palpi ten-jointed; ovigerous legs ten-jointed.	
1081 to 1539.	*Ascorhynchus abyssi*, G. O. Sars, Arch. f. Math. og Naturvid., ii. 367, 1877. This well-characterised species is (according to Sars) very common in the great depths of the cold region.	Atlantic between Iceland and Norway. Lat. 63° 7′ N., long. 1° 26′ W.; lat. 68° 13′ 5″ N., long. 0° 33′ E.
1375	**Ascorhynchus glaber*, n. sp. A beautiful and large *Ascorhynchus*: not very different from *A. abyssi*. G. O. Sars, Arch. f. Math. og Naturvid., ii. 367, 1877.	Between Cape of Good Hope and Kerguelen.
(?)	*Ascorhynchus ramipes*, Böhm (sp.). *Gnamptorhynchus ramipes*, Böhm, Sitzber. der Ges. Naturf. Freunde zu Berlin, 1879, p. 56. *Ibid.*, p. 140.	Enosima (Japan).
38	**Ascorhynchus minutus*, n. sp. A well-characterised species, nearly allied to *A. ramipes*, Böhm.	Southern Coast of Australia: off entrance to Port Philip.
130	**Ascorhynchus orthorhynchus*, n. sp. A very fine and, I believe, well-characterised species.	Great Ocean, North of Admiralty Islands.
	Zetes, Kröyer (1845).	
	Mandibles rudimentary, three-jointed; palpi ten-jointed; ovigerous legs nine- (nonne ten- (?)) jointed; proboscis long-ovate.	
(?)	*Zetes hispidus*, Kröyer, Naturhist. Tidskr. Ny Raekke, i. 117, 1845. *Zetes hispidus*, Kröyer, Jarzynsky, Præmissus Catalogus, Annales de la Soc. des Natur. de St Petersbourg, 1870.	Coast of Greenland, Coast of Russian-Lapland.

Depth in Fathoms.	Name.	Geographical Distribution.
	Parazetes, Slater (1879). Mandibles rudimentary, two-jointed; palpi nine-jointed; ovigerous legs ten-jointed; proboscis fusiform.	
(?)	*Parazetes auchenicus*, Slater, Annals and Mag. of Nat. Hist., 5th series, iii. 281, 1879. Slater calls the generic characteristic of *Parazetes* "distinct." The description of the genus and species has been given from a single specimen, so I doubt whether the generic differences from *Zetes* or any other closely-allied genus will hold good.	Off Cape Sima (Japan).
	Pariboea, Philippi (1843). Mandibles rudimentary, two-jointed; palpi five-jointed; ovigerous legs nine (nonne ten- (?)) jointed; proboscis ovate.	
(?)	*Pariboea spinipalpis*, Philippi, Arch. f. Naturg., 1843, ix. p. 178. Perhaps the description of this species is not taken from an adult specimen.	Sorrento (Gulf of Naples).
	Alcinous, Costa (1861). Mandibles rudimentary, three-jointed; palpi seven- or nine-jointed; ovigerous legs eight-jointed; proboscis long-ovate.	
(?)	*Alcinous vulgaris*, Costa, Microdoride mediterranea, Napoli, 1861, p. 13. This species has, I believe, a certain resemblance to an *Ascorhynchus*.	Mediterranean.
(?)	*Alcinous megacephalus*, Costa, Microd. medit. Napoli, 1861, p. 14. This species belongs rather to *Pariboea*, Philippi, than to *Alcinous*, Costa.	Gulf of Naples.
	Achelia, Hodge (1864). Mandibles rudimentary, two-jointed; palpi eight-jointed; ovigerous legs ten-jointed; proboscis pyriform.	
Low water mark to 17 fathoms; 35 fathoms.	*Achelia spinosa*, Stimpson (sp.). *Zetes spinosa*, Stimpson. Invertebrata of Grand Manan, 1853, p. 37. *A. spinosa*, Wilson, Pycnogon. of New England, Trans. Connect. Acad. of Arts and Sciences, vol. v. p. 7, 1880. The differences of *A. spinosa*, Stimpson, from Hodge's *A. echinata* "seem scarcely sufficient to separate them as distinct species" (Wilson, *loc. cit.*).	Grand Manan; Eastport, Casco Bay, off Block Island, &c.
Low tide to a few faths. (Hodge).	*Achelia echinata*, Hodge, British Pycnogonoidea, Ann. and Mag. of Nat. Hist., 3d ser., vol. xiii. p. 115, 1864. A good description of this species has been given by Grube, St Vaast la Hougue und seine Meeres—besonders seine Anneliden-Fauna, Verhandl. d. Schles. Gesellsch. f. vaterl. Cultur, 1869–72, p. 27 (Separatabdruck). Perhaps identical with *A. spinosa*, Stimpson, Invertebrata of Grand Manan, 1853, p. 37.	Channel Islands, Isle of Man; Durham Coast, St Vaast la Hougue, Dutch Coast.

Depth in Fathoms.	Name.	Geographical Distribution.
(?)	*Achelia lævis*, Hodge, British Pycnogonoidea, Ann. and Mag. of Nat. Hist., 3d ser., vol. xiii. p. 115, 1864. Böhm (Monatsb. d. K. Akad. der. Wiss. in Berl., 1879, p. 186) refers to the same species a specimen from Kerguelen with seven-jointed palpi.	Polperro, Cornwall (Hodge), Nizza (Grube), Kerguelen (Böhm).
(?)	*Achelia hispida*, Hodge, British Pycnogonoidea, Ann. and Mag. of Nat. Hist., 3d ser., vol. xiii. p. 115, 1864. I doubt, whether this species described by Hodge is indeed a true species.	Polperro, Cornwall.
	Tanystylum, Miers (1879).	
	Mandibles rudimentary, one-jointed; palpi six-jointed; ovigerous legs ten-jointed; proboscis rounded-conical.	
5 to 7	*Tanystylum styligerum*, Miers, Crustacea of Kerguelen Island, Phil. Trans. London, vol. clxviii., extra vol., pp. 200–214, pl. xi., 1879. *Nymphon styligerum*, Miers (sp.), Ann. and Mag. of Nat. Hist., 4th ser., vol. xvi., 1875. Most probably this is a good species; however, I do not feel quite sure that the two specimens studied by Miers are really full-grown animals.	Kerguelen Island, Observatory Bay.
Down to 14 fathoms (Wilson).	*Tanystylum orbiculare*, Wilson, Pycnogonida of New England, Trans. Connect. Acad., vol. v. p. 5, 1880. Whether or not *Tanystylum* will prove a well-characterised genus, or will turn out to be identical with *Achelia*, Hodge, is doubtful as yet.	Vineyard Sound, and occurs as far south as Virginia (Wilson, *loc. cit.*).
	Lecythorhynchus, Böhm (1879).	
	Mandibles rudimentary, two-jointed or represented by small knobs; palpi nine-jointed; ovigerous legs ten-jointed; proboscis cylindrical.	
3 to 4 fathoms.	*Lecythorhynchus hilgendorfi*, Böhm, Monatsb. der K. Akad. d. Wiss. Berlin, 1879, p. 187. *Corniger hilgendorfi*, Böhm (sp.), *ibid.* and Sitzungsber. d. Ges. Naturf. Freunde zu Berlin, 1879, p. 140. Böhm has given a good description of this species, *loc. cit.*	Enosima (Japan).
(?)	*Lecythorhynchus armatus*, Böhm, Sitzungsber. der Ges. Naturf. Freunde zu Berlin, 1879, p. 140. *L. hilgendorfi*, Böhm, is furnished with rudimentary mandibles represented by small knobs; *L. armatus*, Böhm, with rudimentary but two-jointed mandibles. There can be no doubt, however (according to Böhm), that these species belong to the same genus.	Yeddo (Japan).
	Oorhynchus, Hoek (1880).	
	Mandibles rudimentary, one-jointed; palpi nine-jointed; ovigerous legs ten-jointed; proboscis broadly ovate.	
700	**Oorhynchus aucklandiæ*, n. sp. Of this very characteristic Pycnogonid, only a single specimen was dredged during the voyage of H.M.S. Challenger.	East of Auckland.

Depth in Fathoms.	Name.	Geographical Distribution.
	Colossendeis, Jarzynsky (1870). No mandibles; palpi ten-jointed; ovigerous legs ten-jointed; proboscis long, cylindrical, club-shaped or bottle-shaped.	
120 to 250 (Jarzynsky). 110 to 166 (Hoek in MS.). 540 ("Knight Errant").	**Colossendeis proboscidea*, Sabine (sp.). *Phoxichilus proboscideus*, Sabine, Supplement to the Appendix of Captain Parry's Voyage, Zoology, p. ccxxvi. *C. borealis*, Jarzynsky, Præmissus catalogus Pycnogonidarum inventarum in mari glaciali ad oras Lapponicæ rossicæ et in mari albo, anno 1869 et 70, Annales de la Soc. des Natur. de St Petersb., 1870. *C. proboscidea*, Sabine, G. O. Sars. Prodromus descriptionis, &c., Arch. f. Math. og Naturv., ii. 268, 1877. A gigantic Pycnogonid of the higher northern latitudes.	Coast of Russian-Lapland, North Atlantic. Lat. 62° 44′ 5″ N., long. 1° 48′ E. Barents Sea (Hoek in MS.), North of Scotland ("Knight Errant").
55 to 120	**Colossendeis megalonyx*, n. sp. A well-characterised species. In some respects it resembles the *C. proboscidea*, Sabine, of the higher northern latitudes; it has, however, a much more slender body and longer legs.	Lat. 50° S.: Kerguelen; between Patagonia and the Falkland Islands.
417	*Colossendeis angusta*, G. O. Sars, Prodromus descriptionis, &c., Arch. f. Math. og Naturvid., ii. 268, 1877. This species is the slender *Colossendeis* of higher nothern latitudes.	North Atlantic; lat. 63° 10′ 2″ N., long. 4° 59′ 6″ E.
400; 1375; 1600	**Colossendeis leptorhynchus*, n. sp. This species seems to be a very good one. It is easily recognized by its extremely long and narrow proboscis, of an almost cylindrical shape.	Between Kerguelen and Cape of Good Hope; West of Valparaiso; between Hanover Isle and Patagonia.
1800	**Colossendeis gigas-leptorhynchus*. A single specimen of this form was dredged at Station 158. It shows the proboscis of *C. gigas*, whereas the palpi are those of *C. leptorhynchus*. In other respects it resembles both species.	South of Australia at the fiftieth parallel.
1375 to 1600	**Colossendeis gigas*, n. sp. This seems to be the largest, not only of the species of the genus *Colossendeis*, but of all the different forms hitherto described.	Between Cape of Good Hope and Kerguelen; between Juan Fernandez and Valparaiso.
25	*Colossendeis kröyerii*, Wood-Mason (sp.). *Rhopalorhynchus kröyerii*, Wood-Mason. A small but very characteristic species of the genus *Colossendeis*.	Andaman Islands (Port Blair).
120	**Colossendeis robusta*, n. sp. A beautiful species, easily to be recognised by the form of its proboscis, &c.	Kerguelen.
1375 to 1600	**Colossendeis gracilis*, n. sp. The species *C. media*, *C. brevipes*, and *C. gracilis*, proposed by me, only show very slight differences. In regard to *C. gracilis*, I think it is a very interesting fact, that one of the specimens is furnished with distinct mandibles.	Between Cape of Good Hope and Kerguelen.
2225	**Colossendeis media*, n. sp. Characterised by the long claws of the legs, and by the peculiar shape of the last joints of the palpi.	West of Valparaiso.

Depth in Fathoms.	Name.	Geographical Distribution.
2650	**Colossendeis brevipes*, n. sp. In all probability nearly allied to *C. media*, Hoek, and *C. gracilis*, Hoek. Perhaps not a distinct species but only a variety.	East of Buenos Ayres.
1250	**Colossendeis minuta*, n. sp. A very slender and easily recognised species.	South of Halifax.
	Pasithoe, Goodsir (1842).	
	No mandibles; palpi eight-jointed; ovigerous legs nine- (nonne ten-) jointed.	
(?)	(?) *Pasithoe vesiculosa*, Goodsir, Edin. New Phil. Journal, vol. xxiii. 1842. Description and characterisation of species and genus insufficient.	Coast of England.
	Endeis, Philippi (1843).	
	No mandibles; palpi seven-jointed; ovigerous legs nine- (nonne ten-) jointed.	
(?)	*Endeis didactyla*, Philippi, Ueber die Neapolitanischen Pycnogoniden, Arch. f. Naturgesch. ix., 176, 1843. Body ovate, ovigerous legs present. I think this must be considered as a true representative of the genus *Endeis*, proposed by Philippi. Semper (Ueber Pycnogoniden, Arb. Zool. Zoot. Inst. in Würzburg, i. 281, 1874) considers it as a species of *Pasithoe*, Goodsir. But this question cannot be settled without more detailed descriptions of the forms in question.	Naples.
(?)	(?) *Endeis gracilis*, Philippi, Ueber die Neapolit. Pycnog., Arch. f. Naturg., ix. 176, 1843. This species has a very slender body. No ovigerous legs are mentioned: perhaps the eight-jointed palpi are in reality the ovigerous legs, and this is a species of *Phoxichilus* without palpi.	Naples.
	Discoarachne, Hoek (1880).	
	No mandibles; palpi five-jointed; ovigerous legs ten-jointed.	
Shore.	**Discoarachne brevipes*, n. sp. A very curious species with a disciform body and short legs.	Near Cape Town.

Family III. Pallenidæ.

Contains those Pycnogonida, which have strongly developed cheliform mandibles, and either rudimentary palpi or no palpi at all. Ovigerous legs are present in both sexes, and furnished with denticulate spines (*Pallene*), or present in both sexes and not furnished with denticulate spines (some species of *Phoxichilidium*), or present only in the males (other species of *Phoxichilidium*). Two genera: *Pallene*, *Phoxichilidium*.

Depth in Fathoms.	Name.	Geographical Distribution.
	Pallene, Johnston (1837). Mandibles cheliform; palpi wanting; ovigerous legs ten-jointed, present in both sexes. The last four joints of the ovigerous legs often furnished with denticulate spines.	
Shore.	*Pallene brevirostris*, Johnston, An Attempt to ascertain, &c., Mag. of Zool. and Bot., vol. i. 1837. *P. brevirostris*, Johnston, Grube, Mittheilungen über St Vaast la Hougue, &c., Verhandl. der Schl. Ges. f. vaterl. Cultur., 1859. *P. brevirostris*, Johnston, Hoek, Ueber Pycnogoniden, Niederl. Arch. f. Zool., iii., 1877. A well-characterised species.	Northern Europe (Coast of England, France, of the Netherlands).
0 to 3	(?) *Pallene empusa*, Wilson, Pycnogonida of New England, Trans. Connect. Acad., vol. v. p. 9, 1880. This species is so closely allied to *P. brevirostris*, Johnston, of the European coast, that it must be considered either as the same, or as a variety of that species.	Vineyard Sound, Noank, Connecticut (U. S. A.).
(?)	(?) *Pallene chelifera*, Claparède (sp.), Beobachtungen über wirbellose Thiere, p. 103, 1863. Claparède gives a very insufficient description of this species, which he considers as a *Phoxichilidium*. I think it most probable, that it is closely allied to *P. brevirostris*, Johnston.	French Coast.
(?)	*Pallene spinipes*, Fabr. *Pycnogonum spinipes*, Fabr. (sp.), Fauna Grönl., p. 232. *Pallene spinipes*, Fabr., Kröyer, Bidrag til Kundskab, Naturhist. Tidskr., Ny Raekke, i. 118, 1845. *Pallene spinipes*, Fabr., Jarzynsky, Præmissus Catalogus, Annales de la Soc. des Natur. de St Petersb., 1870.	Coast of South Greenland; White Coast of Russian-Lapland.
38 to 40	**Pallene lævis*, n. sp. A well characterised *Pallene* species.	South Coast of Australia.
(?)	*Pallene chiragra*, Milne-Edw., Histoire Natur. des Crustacés, tom. iii. p. 535, 1840. The description of this species given by Milne-Edw., *loc. cit.*, is insufficient. Perhaps it is the same as the species for which I propose the name *P. australiensis*.	Australia (Jervis Bay).
38 to 120	**Pallene australiensis*, n. sp. Perhaps it is this species, which has been described by Milne-Edwards as *P. chiragra* (Hist. Nat. des Crust., iii. 535, 1840).	South-east Coast of Australia.
(?)	*Pallene grubii*, Hoek. I propose this name for the species described by Grube (Jahresb. der Schles. Ges. f. vaterl. Cultur., p. 54, 1869), and which Grube considered as a species of *Phoxichilidium*.	China Sea.
(?)	*Pallene longiceps*, Böhm, Sitzungsber. des Ges. naturf. Freunde zu Berlin, p. 59, 1879. A very curious species with rudimentary two-jointed palpi in the male sex.	Japan.
38	**Pallene languida*, n. sp. Nearly allied to *P. longiceps*, Böhm (Sitzungsber. des. Ges. Naturf. Freunde in Berlin, 1869).	Melbourne (Australia).

Depth in Fathoms.	Name.	Geographical Distribution.
(?)	*Pallene intermedia*, Kröyer, Bidrag til Kundskab, Naturh. Tidskr., Ny Raekke, i. 119, 1845.	Coast of South Greenland.
(?)	*Pallene discoidea*, Kröyer, Bidrag til Kundskab, Naturhist. Tidskr., Ny Raekke, i. 120, 1845. *Pallene discoidea*, Kröyer, Jarzynsky, Præmissus Catalogus, Annales de la Soc. des Natur. de St Petersbourg, 1870.	Coast of South Greenland, White Sea, Coast of Russian-Lapland, and North Norway.
12	*Pallene hispida*, Stimpson, Invertebrata of Grand Manan, p. 37, 1853. *Pseudopallene hispida*, Stimpson (sp.), Wilson, Amer. Jour. of Sc. and Arts, vol. xv. p. 200, 1878, Trans. Connect. Acad., v. 10, 1880. Wilson considers this species, which is a true *Pallene*, as representing a new genus, which he calls *Pseudopallene*. But there is no difference in the number of the joints of the ovigerous legs, and the presence or absence of auxiliary claws furnishes by no means a trustworthy ground for division of the genus. "This species is very similar to the last (*P. discoidea*, Kröyer) and a larger number of specimens may show them to be identical" (Wilson, *ibid.*).	Near Eastport, Maine; off Grand Manan.
(?)	*Pallene lappa*, Böhm, Pycnogoniden des Museums zu Berlin, Monatsber. der K. Ak. der Wissensch. zu Berlin, 182, 1879. I was long in doubt whether this species was a true *Pallene* or a *Phoxichilidium*. I have arrived at the conclusion that it is indeed a *Pallene*, but a young one, with not quite developed ovigerous legs.	Mozambique.
(?)	(?) *Pallene circularis*, Goodsir, Edin. New Phil. Journal, vol. xxxii. p. 136, 1842. Goodsir's description is insufficient. Perhaps this species is nearly allied to *P. discoidea*, Kröyer, Bidrag til Kundskab, Naturhist. Tidskr., Ny Raekke., i. 120, 1845.	Scotland.
191 to 459	*Pallene malleolata*, G. O. Sars, Crustacea et Pycnogonida nova, Arch. f. Math. og. Naturvid., iv. 469, 1879. Seems to be a species characteristic of the higher northern latitudes.	Lat. 72° 27′ to 80° N., long. 5° 40′ to 20° 51′ E.

Phoxichilidium, Milne-Edwards (1840).

Basis of the proboscis dorsally covered by the front part of the cephalothoracic segment. On this front part the oculiferous tubercle is placed. Mandibles cheliform; palpi wanting; ovigerous legs five- to ten- (?) jointed, the last four joints never furnished with denticulate spines; in some species present in both sexes, in others only in the male sex.

Shore.	*Phoxichilidium femoratum*, Rathke (sp.). *Nymphon femoratum*, Rathke, Naturh. Selsk. Skr., v., i. 201,	Greenland, Russian - Lapland (Jarzynsky), Norway, Den-

Depth in Fathoms.	Name.	Geographical Distribution.
	1799. *Orithyia coccinea*, Johnston, An Attempt, &c., Magazine of Zoology and Botany, vol. i. p. 378, 1837. *P. femoratum*, Rathke, Kröyer, Bidrag til Kundskab, Naturh. Tidskr. i., 1845; Hoek, Ueber Pycnogoniden, Niederl. Arch. f. Zool., iii., 1877. This is the largest of the *Phoxichilidiums* occurring in the neighbourhood of the shores of the North Sea. (Ovigerous legs, occurring only in the males, five-jointed).	mark, Heligoland, England, Holland.
(?)	(?) *Phoxichilidium globosum*, Goodsir, Edin. New Philos. Journ., xxxii., 1842. Description quite insufficient, probably a female of some species or other.	North Atlantic (Orkney).
Low water mark (Wilson).	*Phoxichilidium maxillare*, Stimpson, Invertebrata of Grand Manan, 37, 1853. *P. maxillare*, Stimpson, Wilson, Pycnogonida of New England, Trans. Connect. Acad., vol. v. p. 12, 1880. I never saw this species. Wilson says it resembles *P. femoratum* of Europe. It has five-jointed ovigerous legs, wanting in the female.	Bay of Fundy, Casco Bay, Halifax (East Coast of North America).
Tide-pools.	*Phoxichilidium minor*, Wilson, Pycnogonida of New England, Trans. Connect. Acad., v. 13, 1880. Smaller than *P. maxillare*, to which it is closely allied. It has also five-jointed ovigerous legs, wanting in the female. It may be a dwarf variety of *P. maxillare* (Wilson).	Casco Bay (East Coast of North America).
(?)	(?) *Phoxichilidium mutilatum*, Frey u. Leuckart, Beiträge zur Kenntniss wirbelloser Thiere, p. 165, 1847. With the fourth pair of legs rudimentary and one-jointed ovigerous legs. No doubt the description is taken from an immature specimen.	Heligoland.
30 to 42 (Böhm). 7 to 20 (Challenger).	* *Phoxichilidium fluminense*, Kröyer, Bidrag til Kundskab, Naturh. Tidskr., N. R., i., 1845. *Pallene fluminensis*, Kröyer (sp.), Böhm, Pycnogoniden des Museums zu Berlin, Monatsber. der Konigl. Akad. der Wiss., p. 180, 1869. Dredged during the Challenger Expedition off Bahia. Ovigerous legs in both sexes, ten-jointed.	Coast of Patagonia, Magellan Strait, Coast of Brazil.
7 to 20	* *Phoxichilidium insigne*, n. sp. A very characteristic species, with an extremely slender body armed with spine-forming knobs.	Bahia.
(?) (Probably 25 to 35).	*Phoxichilidium petiolatum*, Kröyer, Bidrag til Kundskab, Naturh. Tidskr., i., 1845. *Pallene attenuata*, Hodge, Report British Association, 119, 1862. After Hodge (Ann. and Mag. of Nat. Hist., vol. xiii., 3d series, p. 116, 1864). *Pallene attenuata* is a synonym of Kröyer's *P. petiolatum*. Ovigerous legs seven-jointed, wanting in the female.	Coast of Norway (Oeresund), Coast of Northumberland, Doggerbank.

Depth in Fathoms.	Name.	Geographical Distribution.
48 to 175	**Phoxichilidium patagonicum*, n. sp. A beautiful species. It was dredged at different stations in the neighbourhood of the Patagonian coast.	Patagonia.
600	**Phoxichilidium patagonicum*, var. *elegans*, Hoek. Whether this is a true variety of the preceding species, or is only to be considered as a young specimen of this species, I am unable to ascertain.	East of Cape Corrientes (La Plata).
(?)	*Phoxichilidium digitatum*, Böhm, Pycnogoniden des Museums zu Berlin, Monatsber. der K. Akad. der Wiss. in Berlin, 184, 1879. Perhaps nearly allied to my *P. patagonicum* (ovigerous legs occurring only in the males. Number of joints ?)	Singapore.
(?)	(?) *Phoxichilidium pygmæum*, Hodge (sp.). *Pallene pygmæa*, Hodge, British Pycnogonoidea, Ann. and Mag. of Nat. Hist., 3d series, vol. xiii., 1864. As far as I could ascertain from the extremely insufficient description of Hodge, and from his figures, this species belongs to the genus *Phoxichilidium.* One of the species of *Phoxichilidium* occurring on the French and on the Dutch coast is probably the same species. Should this prove to be true the ovigerous leg is six-jointed and occurs only in the male.	England.
Shore.	*Phoxichilidium virescens*, Hodge, British Pycnogonoidea, Ann. and Mag. of Nat. Hist., 3d series, vol. xiii., 1864. Description insufficient. As far as I could make out it is one of the more common forms of the Dutch and French coast. (Ovigerous legs wanting in the female, six-jointed.)	English Coast (Polperro), French Coast (Grube, Mittheilungen über St Malo u. Roscoff).
Tide-marks to 6 fathoms.	*Phoxichilidium lentum*, Wilson (sp.). *Anoplodactylus lentus*, Wilson, Pycnogonida of New England, Trans. Connect. Acad. of Arts and Sc., vol. v. p. 14, 1880. Wilson gives this name to the species described by Smith (Report Invertebrata of Vineyard Sound, p. 250) as *Phoxichilidium maxillare.* I think it is closely allied to *Phoxichilidium virescens*, Hodge (Ann. and Mag., 3d. ser., vol. xiii. p. 115, 1864). Ovigerous legs only in the male, six-jointed.	Vineyard Sound; Bay of Fundy (New England).
1675	**Phoxichilidium oscitans*, n. sp. A very curious deep-sea species, easily to be recognised.	Atlantic: West of Azores.
1600 to 1950	**Phoxichilidium pilosum*, n. sp. A beautiful deep-sea species.	Between Cape Town and Kerguelen; between Kerguelen and Melbourne.
1875	**Phoxichilidium mollissimum*, n. sp. Unfortunately only a defective specimen of this curious form was dredged by the Challenger Expedition. It has ten-jointed ovigerous legs.	Off Yeddo (Japan).

Depth in Fathoms.	Name.	Geographical Distribution.
(?)	*Phoxichilidium johnstonianum*, White (sp.). *Nymphon johnstonianum*, White, Proc. Zool. Soc. of London, vol. xv., 1847. There can be no doubt that this species belongs to *Phoxichilidium*: eyes situated above the insertion of the chelicera (mandibles); beak (proboscis) springing from the under side of the head; chelicera with two basal joints, &c. The description, however, is hardly sufficient. What White describes as palpi are in all probability the ovigerous legs.	South Seas.
(?)	(?) *Phoxichilidium phasma*, White (sp). *Nymphon phasma*, White, Proc. Zool. Soc. of London, vol. xv., 1847. Whether this species also belongs to this genus or is to be considered as a *Pallene* (it is certainly not a *Nymphon*) is not to be ascertained. White says it may possibly be the other sex of the preceding	South Seas.
	Oomerus, Hesse (1874).	
	Oculiferous tubercle placed at the base of the proboscis; mandibles with long pincers; palpi represented by small knobs; ovigerous legs not present in the female.	
(?)	(?) *Oomerus stigmatophorus*, Hesse, Ann. d. Sc. Nat. Zool., 5ième série, xx., 1874, art. 5, p. 18, pl. viii. In all probability this is a species of the genus *Phoxichilidium*, Milne-Edwards. Only a female without ovigerous legs, and with highly developed ovaries in the fourth joint of the leg, was observed by Hesse.	Brest (Bretagne).

Family IV. Phoxichilidæ.

Contains those Pycnogonida, which have neither mandibles nor palpi, or have them rudimentary. Ovigerous legs, as a rule, only in the males, whereas *Hannonia* possesses them in both sexes; always without denticulate spines. Genera: *Hannonia, Phoxichilus, Pycnogonum.*

Depth in Fathoms.	Name.	Geographical Distribution.
	Hannonia, Hoek (1880).	
	Mandibles rudimentary, chelate, two-jointed; no palpi; ovigerous legs ten-jointed, present in both sexes.	
Shore.	**Hannonia typica*, n. sp. A short-legged species, a true littoral form, with very characteristic features.	Cape of Good Hope.

Depth in Fathoms.	Name.	Geographical Distribution.
	Phoxichilus, Latr. (1816).	
	Mandibles and palpi wanting; ovigerous legs, seven-jointed, present only in the males; body, as a rule, slender.	
Shore.	*Phoxichilus spinosus*, Montagu (sp.). *Phalangium spinosum*, Montagu, Linn. Transact., vol. ix. p. 100, pl. v. fig. 7, 1808. *P. spinosus*, Montagu, Johnston, An Attempt, &c., Magaz. of Zool. and Bot., i. 1837. *Phoxichilus spinosus*, Mont., Kröyer, Bidrag til Kundskab Naturh., Tidskr. Ny. Raekke, i., 1845. The *Phoxichilus spinosus*, Leach, as described and figured by Quatrefages (Ann. d. Sc. Nat. 3ième série, Zool., tom. iv. 1845) is not a *Phoxichilus* at all. Perhaps it is a *Pallene*.	Coast of Norway; Coast of Russian-Lapland (Jarzynsky); England (South Coast of Devonshire).
(?)	*Phoxichilus meridionalis*, Böhm, Pycnogoniden des Museums zu Berlin, Monatsber. der Königl. Akad. der Wissensch. zu Berlin, 1879, s. 189, Taf. ii., fig. 4–4*b*. A species which stands between *P. lævis*, Grube, and *P. inermis*, Hesse (Böhm).	Singapore.
(?)	(?) *Phoxichilus inermus*, Hesse, Ann. d. Sc. Natur., 5ième série, tom. vii. p. 199, 1867. Perhaps nearly allied to *P. lævis*, Grube. Judging from Hesse's description, this species is furnished with a three-jointed abdomen, and this is not the case with Grube's species, nor perhaps with any species of the Pycnogonida. It was taken at Brest on the keel of a ship returning from the Mediterranean.	French Coast or Mediterranean (?).
Shore.	*Phoxichilus lævis*, Grube, Mittheilungen über St Malo und Roscoff, 1872. During a recent visit to Roscoff (Bretagne) I collected specimens of this species, which is easily distinguished from *P. spinosus*, Montagu.	French Coast.
(?)	(?) *Phoxichilus pigmæus*, Costa (*Foxichilus pigmæus*), Fauna del Regno di Napoli, Napoli, 1836, p. 10. This species, characterised by its smallness and by the absence of the spines at the end of the joints of the legs, is perhaps identical with *P. inermis*, Hesse, or *P. lævis*, Grube. Description very insufficient.	Gulf of Naples.
	Pycnogonum, Brünnich (1764).	
	Mandibles and palpi wanting; ovigerous legs nine-jointed, present only in the males; body, as a rule, robust.	
Tide marks to 430 fathoms.	**Pycnogonum litorale*, Ström (sp.). *Phalangium litorale*, Ström, Physisk. og œconomisk beskrivelse over fogderiet Söndmör, Soröe, 1762. *P. litorale*, Ström, Kröyer, Bidrag til Kundskab, Naturh., Tidskr. Ny Raekke, i. 126, 1845. *P. litorale*, O. Fabr.,	North European Coasts and Seas; Coast of Russian-Lapland (Jarzynsky); Coast of North America, as far south as Long Island Sound; Coast of

Depth in Fathoms.	Name.	Geographical Distribution.
	Wilson, Pycnogonida of New England, Transact. Connect. Acad., vol. v. p. 4, 1880. In the Ann. and Mag. of Nat. Hist., 5th series, vol. iii. p. 283, 1879, Slater describes a variety of this species, which, being very slender, is named *P. litorale*, var. *tenue*, Slater. It was dredged by Capt. St John and placed in the British Mus. Catal., 78, 11.	Chili (Gay); Mediterranean; Japan. The greatest depth from which it has been obtained in Europe is, as far as I could ascertain, 53 fathoms ("Knight Errant"), whereas it was dredged by Smith and Harger (1872) at a depth of 430 fathoms, east of St. George's Bank, N. lat. 41° 25′, long. 65° 42′ 3″ W.
(?)	(?) *Pycnogonum australe*, Grube, Jahresb. der Schles. Ges. f. vaterl. Cultur, p. 54, 1869. Of this species only a larva with three pairs of legs has been examined. It seems to be a species with auxiliary claws at the ends of the legs.	Australia.

Description of the Species Dredged during the Challenger Expedition.

Nymphon, Fabr.

Nymphon hamatum, n. sp. (Pl. I.).

Diagnosis.—Body slender, body and legs almost entirely smooth; eyes obsolete, auxiliary claws wanting; second joint of the palpi longer than the third; second joint of the leg longer than the first and the third; second tarsal joint of the leg longer than the first.

Description.—The body is slender, and the lateral processes are separated. The proboscis is large, almost one-third the length of the body, slightly swollen in the middle, and again at the extremity. The mouth is triangular, not very large. The cephalothoracic segment (with the base of the mandibles swollen) is almost as long as the proboscis. The eyes are obsolete, represented only by two small knobs behind the lateral process of the cephalothoracic segment. The abdomen is rather large; the mandibles large, with the basal joint as long as the rostrum; the claws of the chelæ are elongated; the immovable claw more strongly curved than the movable one (Pl. I. fig. 3). Both claws are armed with spines; on the movable claw they are more numerous and larger (fig. 3). Seen but slightly magnified, the mandibles are smooth; when greatly magnified they show small hairs all over the surface.

The palpi are slender, longer than the rostrum; the second joint is longer than the third, the fifth longer than the fourth; they increase in length as follows:—First,

fourth, fifth, third, second. The first and second joints are almost entirely smooth, the third joint with small and the fourth and fifth with stronger hairs.

The ovigerous legs of the males are stronger than those of the females, and in all the specimens are bent as shown in the figure (fig. 2). The fourth joint is curved, the fifth thinner, and much longer than the fourth, and swollen at the extremity; the sixth is short, the seventh, eighth, ninth, and tenth very short; the first joints are sparsely hairy, the fifth not very hairy, the sixth hairy, with a row of stronger hairs at the outer extremity of the joint. The spines of the four last joints are not very denticulated (figs. 4 and 5), their numbers are respectively 12, 10, 9, 12; the end claw is denticulated also.

In the females the ovigerous legs are shorter, and not bent as in the males. The fifth joint is only a little longer than the fourth, the sixth joint is less hairy, the denticulated spines of the four last joints not so numerous, their numbers being respectively 11, 7, 5, 7.

The legs are very long, measuring, for instance, 38 mm. in a female of 11 mm., and 44 mm. in a male of 13·5 mm. (1 : 3·4, and 1 : 3·3); the second joint, which is swollen at the extremity in the females is longer than the first and third joints; the fifth joint is the longest, the sixth not much shorter; the second tarsal joint is longer than the first, the claw is not very strong, nearly half the length of the second tarsal joint (fig. 9). Auxiliary claws are wanting. The fourth joint of the leg, which in the females is swollen with the ovary, is furnished at the extremity with a hook-like process bearing one or two hairs (fig. 8). I believe this is the first species of *Nymphon*, in which this process has been observed, and therefore I have named the species after it. This fourth segment is furnished in the males with a row of knobs, closed at the extremity by a thin perforated membrane (fig. 7). Both males and females have the legs almost entirely smooth, the hairs being so small as to be only visible under the microscope. Larger hairs are seen at the extremity of the joints. The last joints are furnished with small but very dense hairs. The genital openings of the females are large, and easily observed on the lower side of the second joint on each leg (fig. 6). Those of the males are a great deal smaller, and six in number; they are not found at the first pair of legs. The colour of alcoholic specimens is light yellowish (for the larvæ see below).

Habitat.—This very beautiful species was dredged during the Challenger Expedition between the Cape of Good Hope and Kerguelen, off the Crozets Islands. There are in all eight specimens, of which four are males and four females. One of the males was furnished with eggs, or rather with young ones, adhering still to the accessory legs. The species was found at two stations, at 1375 and 1600 fathoms. At the same time were obtained two specimens of *Ascorhynchus glaber*, Hoek, two of *Colossendeis gigas*, Hoek, three of *Colossendeis leptorhynchus*, Hoek, three of *Colossendeis gracilis*, Hoek, and one of *Phoxichilidium pilosum*, Hoek.

Station 146. December 29, 1873. Lat. 46° 46′ S., long. 45° 31′ E.; Depth, 1375 fathoms. Bottom temperature, 1·5° C. Sea bottom, globigerina ooze.

Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E.; Depth, 1600 fathoms. Bottom temperature, 0·8° C. Sea bottom, globigerina ooze.

Observations.—*Nymphon hamatum* is a very fine deep-sea Pycnogonid, and may easily be distinguished from the other species. Among the described species of *Nymphon* it shows some resemblance to *Nymphon macronyx*, Sars, but this species is a great deal smaller, has the mandibles and the legs shorter, shows a very prominent and curious-shaped oculiferous tubercle,[1] and has the claw of the leg as long as the second tarsal joint.

Nymphon longicoxa, n. sp. (Pl. II. figs. 1–5; Pl. XV. figs. 8, 9).

Diagnosis.—Body very slender and smooth; legs almost entirely smooth; eyes small but distinct, oculiferous tubercle rounded; auxiliary claws wanting; second joint of the palpi very long, much longer than the third; second joint of the feet much longer than the first and the third, the sixth joint the longest, the second tarsal joint longer than the first.

Description.—The body is very slender, the lateral processes with large intervals between them. The proboscis is large, one-third of the length of the body, in general resembling that of *Nymphon hamatum*, but a little narrower. The mouth is triangular, not very large. The cephalothoracic segment is as in *Nymphon hamatum*. The eyes are rudimentary, four, situated on a rounded tubercle. The abdomen is longer than in *Nymphon hamatum*.

The mandibles are very long, the basal joint longer than the rostrum, the second joint also very long. The immovable claw, which is curved more strongly than the movable one, is furnished with very large spines, which reach almost to the extremity (Pl. II. fig. 3). The movable claw furnished with smaller spines has the extremity smooth; the mandibles are smooth, the second joint only furnished with microscopic hairs. The palpi are extremely slender, longer than the rostrum, the second joint is very large, the fourth and fifth almost equal, the latter furnished with small hairs (fig. 2).

The ovigerous legs of the full-grown males are characteristic. The fifth joint is very long, and describes an elegant curve; it is divided into two parts by a rudimentary articulation, and is strongly swollen at the extremity. The sixth joint, which is also curved, makes an angle with the foregoing. The four last joints are small, and often bent so as to describe a spiral. The first joints are smooth, at the end of the fifth there is, on the outside, a small quantity of hairs, the sixth is furnished with numerous hairs, and has on the upper surface rows of knobs of a curious shape. I have figured some of them (Pl. XV. fig. 8). They are also present on the fifth joint, but are smaller and not so numerous. The spines of the four last joints are much denticulated (Pl. II. fig. 4); their numbers are respectively 13, 8, 7, 6. The spines of the end-claw are very small and blunt.

[1] See the description hereafter in the Appendix.

The ovigerous leg of the full-grown female is almost entirely straight. The difference in length between the fourth and the fifth joints is not so considerable as in the males; the denticulated spines on the four last joints are more numerous than in the males, their numbers being 19, 12, 10, 9. These curiously-shaped knobs do not occur on the ovigerous leg of the female.

The legs are still longer than those of *Nymphon hamatum*. In a female of 12 mm. they measured 46 mm.; in a male of 9½, 38 mm. (1 : 3·8 and 1 : 4). The second joint is in the males four times as long as the first, in the females a little shorter, but considerably swollen at the extremity; the sixth joint is the longest, being more than once and a half the length of the fifth; the first tarsal joint is shorter than the second, the claw is almost as long as the first tarsal joint, auxiliary claws are wanting (Pl. II. fig. 5). The first joints of the legs are almost entirely smooth, the hairs increasing in number as they approach the extremity of the leg. The genital openings of the females are very large, and are found on every leg. Those of the males are smaller, and found only on the three hinder pairs of legs (Pl. XV. fig. 9). The colour of alcoholic specimens is light yellowish. (For the larvæ see below.)

Habitat.—This fine species was dredged east of Auckland. There are in all twelve specimens, of which only three are females. One of the males was furnished with larvæ clinging to the accessory legs. The depth at which the specimens were found is 1100 fathoms. At the same place two specimens of *Nymphon compactum*, Hoek, were obtained.

Station 168. July 8, 1874. Lat. 40° 28′ S., long. 177° 43′ E. Depth, 1100 fathoms. Bottom temperature, 2·0° C. Sea bottom, grey ooze.

Observations.—I believe this species with its rudimentary eyes to form the transition from the shallow-water species to the true deep-sea species. The very long coxæ render the species easily distinguishable.

Nymphon procerum, n. sp. (Pl. II. figs. 9–12).

Diagnosis.—Body extremely slender, smooth; legs hairy; eyes obsolete; auxiliary claws wanting; the second joint of the palpi a little longer than the third, the second joint of the leg longer than the first and the third, the second tarsal joint of the leg a little longer than the first.

Description.—The body is very slender, and the lateral processes are separated by large intervals. The proboscis is slender, shorter than one-third of the length of the body, in the middle a little thicker. The cephalothoracic segment is longer than the proboscis. Eyes are wanting; the abdomen is small and bent upwards. The mandibles are very long, the basal joint longer than the rostrum, the second joint also long and slender, the claws very long; the spines of the movable claw are smaller, and closer to one another than are those of the immovable one (Pl. II. fig. 10). The palpi are very slender, much longer than the rostrum; the second joint is a little longer than the third; the fourth and

fifth together are as long, or a little longer than the second joint. The palpi are nearly hairless, only the last joints being furnished with very small hairs. The ovigerous legs are feeble, shorter than the length of the body, the fourth joint has a distinct knob at a distance of nearly a third of its length, measured from the beginning ; the fifth joint is the longest, the sixth half the length of the fifth, the seventh to the tenth armed with sharply denticulated spines (Pl. II. fig. 12) ; the claw has numerous and dense spines (Pl. II. fig. 11). The ovigerous legs are almost entirely smooth.

The legs are slender, being more than three times as long as the very long and slender body (body 12 mm., legs 38 mm.). The second joint is longer than the first and third, and is considerably swollen ; the fourth joint is swollen with the ovaries, and is nearly as long as the fifth joint, the sixth joint is the longest. The two tarsal joints describe a slight curve, the second is a little longer than the first, the claw is short, auxiliary claws are wanting. The fourth, fifth, and sixth joints have long but not very dense hairs. The seventh and eighth joints have denser but very small hairs. The second joint of each leg is furnished with a large genital opening.

Habitat.—The single female specimen of this species was dredged West of Valparaiso, at a depth of 2160 fathoms.

Station 299. December 14, 1875. Lat. 33° 31′ S., long. 74° 43′ W. Depth, 2160 fathoms. Bottom temperature, 1·1° C. Sea bottom, grey mud.

Observations.—There can be little doubt, I believe, that this species is closely allied to the two foregoing species. Yet I think its extremely slender and elongated form of body characteristic enough to establish a new species upon it. With the exception of *Nymphon longicollum*, dredged from a depth of 2225 fathoms, of all the genus *Nymphon procerum* inhabits the greatest depth.

Nymphon longicollum, n. sp. (Pl. III. figs. 1–3 ; Pl. XV. fig. 11).

Diagnosis.—Body slender; distance between the insertion of the rostrum and the attachment of the ovigerous legs very great ; eyes obsolete, auxiliary claws extremely small. The second joint of the palpi twice as long as the third, the second joint of the leg three times as long as the first, the second tarsal joint of the leg nearly as long as the first.

Description.—The body is slender, the proboscis long, and exactly cylindrical ; the cephalothoracic segment is much longer than one-third of the length of the body. The intervals between the lateral processes of the body are very large, they are totally wanting between the attachment of the ovigerous leg and of the first true leg. Eyes are wanting, but the conical oculiferous tubercle is very large and acute. The abdomen is small.

The mandibles have the basal joint as long as the rostrum, the second joint is short, and furnished with short claws. The movable claw is a little longer than the immovable one, the former is curved at the extremity, the latter straight. The spines

on the claws are not very prominent (Pl. III. fig. 3). The two joints are sparsely hairy, but the hairs of the second joint are longer than those of the first.

The palpi are not very long, and are feeble. The second joint is considerably longer than the third; the first and second together are nearly as long as the last three together. The hairs are much more numerous on the outer joints than on the first two.

The ovigerous legs are not very long. The first four joints are almost entirely smooth, with the exception of some long hairs at the extremity of the fourth joint; the fifth and sixth are hairy when seen through the microscope, the spines of the four last joints are sharply denticulated, their numbers being respectively 9, 6, 5, 5. On the claw there are five not very strong spines. The fifth joint of the ovigerous leg is the longest.

The legs are very slender. The length of the body of the single specimen is nearly 6 mm., that of the leg 26 mm. The second joint is three times as long as the third, the fourth and fifth are nearly equal, the sixth united with the two tarsal joints are as long as the fourth and fifth together. The first tarsal joint is at the first leg a great deal shorter than that of the second. In the other legs the difference between the two tarsal joints is not so considerable; the claw is half as long as the second tarsal joint. The auxiliary claws are extremely small (Pl. XV. fig. 11). The legs, when examined with a magnifying glass of small strength, are quite smooth; when magnified greatly they show small hairs which increase in number and size towards the extremity of the leg (?). The single specimen of this species brought home by the Challenger is in all probability a male. The animal is perhaps a young one, as I failed to observe the genital openings.

Habitat.—The specimen was dredged off the coast of Chili.

Station 298. November 17, 1875. Lat. 34° 7′ S., long. 73° 56′ W. Depth, 2225 fathoms. Bottom temperature, 1·3° C. Sea bottom, grey mud.

Observations.—This curious species is very easily distinguished by its extremely long neck and legs, the latter being more than four times as long as the body. From its long slender neck it bears a certain resemblance to *Nymphon longitarse*, Kr. It is a true deep-sea species.

Nymphon compactum, n. sp. (Pl. II. figs. 6–8; Pl. XV. fig. 10).

Diagnosis.—Body stout, sparsely hairy; eyes obsolete; auxiliary claws wanting. Second joint of the palpi longer than the third, the second joint of the leg longer than the first, the second tarsal joint shorter than the first.

Description.—The body is stout, the proboscis thick and swollen a little in the middle, and again at the extremity; the length about one-third of the length of the body. The cephalothoracic segment is short, swollen anteriorly, and constricted in the middle. Eyes are wanting, the oculiferous tubercle is represented by a blunt knob (fig. 7). The abdomen is long. The intervals between the lateral processes of the body are small. The body is almost smooth, and the lateral processes are furnished with long hairs. The mandibles

are long, the first joint a little curved, and much longer than the proboscis; at the ventral side this joint shows feebly an articulation near the base; the second is shorter, but furnished with very long claws, which are curved at the extremity, and both are armed with almost the same number of spines. The hairs on the mandibles are distant, the largest quantity being observed on the base of the immovable claw. The palpi are not very slender, yet a great deal longer than the proboscis; the second joint is the longest, then follow the third, the fifth, the fourth, and the first, which is the shortest of all. On the first two joints the hairs are not so numerous as on the last three joints.

The ovigerous legs of the female (the two specimens dredged by the Challenger were both females) are tolerably long and stout, once and a third as long as the body; the fourth, fifth, and sixth joints are nearly of the same length, the fourth being the longest, and the sixth the shortest. The four last joints again are of about the same length, the claw is slender, its length two-thirds the length of the last joint. Joints one to four are almost entirely smooth, with the exception of a row of hairs at the end of the fourth joint; joints five and six are furnished with numerous spines, the last four joints showing hairs only at the distal extremity. The spines of the four last joints (figured on Pl. II. fig. 8) are of a very irregular shape, and not very numerous, their numbers being respectively 10, 8, 5, 7. The spines of the claw are not very strong.

The legs are three times as long as the body (36 mm. in a body of 12 mm.). The second joint is longer than the first and third, and swollen, as is always the case in the females. The fourth joint is also very considerably swollen (with the ovaries), the fifth and the sixth joints are nearly of the same length, and a little longer than the fourth; of the two tarsal joints, which are together nearly two-thirds the length of the sixth joint, the first is longer than the second (Pl. XV. fig. 10). The claw is half the length of the second tarsal joint, auxiliary claws are wanting. The fourth joint of the leg is sparsely hairy, the fifth a little more so, the sixth is very hairy and shows some strong spines at the extremity, the two tarsal joints are covered with very minute hairs. The genital openings are large and easily seen.

Habitat.—Of this species two females were dredged along with *Nymphon longicoxa*, east of Auckland.

Station 168. July 8, 1874. Lat. 40° 28′ S., long. 177° 43′ E. Depth, 1100 fathoms. Bottom temperature, 2·0° C. Sea bottom, grey ooze.

Observations.—*Nymphon longicoxa* and *Nymphon compactum* were obtained from a depth of 1100 fathoms. *Nymphon longicoxa* shows rudimentary eyes, those of *Nymphon compactum* are quite obsolete. *Nymphon longicoxa* is one of the most slender, *Nymphon compactum* one of the stoutest species dredged by the Challenger. In the one the auxiliary claws are wanting, whereas small ones are present in *Nymphon longicoxa*, and in every other respect they are as widely different as two species of the same genus of Pycnogonids can be. *Nymphon compactum* shows some relationship to *Nymphon strœmii*,

Kr., but my species may be readily distinguished by its very short cephalic segment, the absence of auxiliary claws, of eyes, &c.

Nymphon meridionale, n. sp. (Pl. III. figs. 4–8).

Diagnosis.—Body slender and smooth, legs not very hairy, slender; eyes four, distinct; auxiliary claws present; second joint of the palpi longer than the third; second joint of the legs elongated, second tarsal joint of the leg shorter than the first.

Description.—The body of this species is slender, the lateral processes are widely separated with the exception of the lateral process of the first leg, and the small process of the ovigerous leg. The proboscis is cylindrical, its length is almost one-third of the length of the body. The cephalothoracic segment with the base of the mandibles is considerably swollen, very large, longer than the two following segments united. The eyes are distinct, four, placed round a small conical tubercle. The abdomen is small.

The mandibles are very long and robust. The first joint is a little curved, and longer than the rostrum, the second joint is also large, and furnished with very strong claws (Pl. III. fig. 5). The movable claw is longer and more deeply curved than the immovable one; both are furnished with a row of blunt and strong spines. The immovable claw shows numerous hairs which are also observed at the base of the movable one. The palpi are very long, the second joint is the longest, the third reaching farther than the rostrum, the fourth and the fifth furnished with numerous hairs, and about the same length.

The ovigerous legs are comparatively small in the single specimen dredged by the Challenger, which I think is a male not yet fully grown. The fifth joint is the longest; the four last joints are furnished with very numerous denticulated spines, their numbers being respectively 17, 16, 13, 13. These spines are comparatively small; they are elongated, and densely denticulated (Pl. III. fig. 6). The claw is not very long, and is furnished to the end with a row of short and blunt spines. All the joints of the ovigerous legs are smooth, with the exception of a few hairs placed at the extremity of the fourth and tenth joints.

The legs are long and slender; the specimen of $6\frac{1}{2}$ mm. shows legs of $21\frac{1}{2}$ mm. The second joint is more than twice as long as the third; the sixth joint is the longest, the second tarsal joint is shorter than the first (Pl. III. fig. 7), the claw is very small, the accessory claws are half as long as the claw (fig. 8); longer hairs are placed at the extremity of every joint, shorter ones cover the outer joints all over, and are a great deal less numerous on the inner joints. The genital openings I could not observe.

Habitat.—The only specimen was dredged in the Antarctic Ocean, at Station 153. February 14, 1874. Lat. 65° 42′ S., long. 79° 49′ E. Depth of the sea, 1675 fathoms. Sea bottom, mud.

Observations.—This is the most southern species of *Nymphon* (of Pycnogonids in general) hitherto observed. I think this form is closely related to *Nymphon gracilipes*,

from Kerguelen; yet the two species may easily be distinguished from each other by the form of the oculiferous tubercle, by the length of the claws of the mandibles, and by the length of the legs, which are in *Nymphon gracilipes*, Miers (after Böhm), five times as long as the body. It is remarkable that this species living at a depth of 1675 fathoms should have normally developed eyes.

Nymphon grossipes, Oth. Fabr. sp. (Pl. III. figs. 9–12; Pl. IV. fig. 1).[1]

Pycnogonum grossipes, Oth. Fabr., Fauna Grœnlandica, p. 229, 1780.

Nymphon grossipes, Oth. Fabr., Kröyer, Bidrag til Kundskab, Naturh. Tidskr. N. R., vol. i. p. 108, 1845.

Nymphon grossipes, Oth. Fabr., Wilson, Pycnogonida of New England, Transactions Connecticut Acad., vol. v. p. 21, 1880.

Description.—The body of this species is slender and almost smooth, the lateral processes are widely separated, with the exception of the small lateral processes of the ovigerous legs, and those of the first pair of true legs, between which no interval is observed. The proboscis is not very long, cylindrical, a little swollen at the extremity. The cephalothoracic segment is longer than the rostrum, swollen considerably at the base of the mandibles. The abdomen is small. The oculiferous tubercle is very prominent, conical, acute. The eyes are four, large (Pl. IV. fig. 1).

The mandibles have a long basal joint, which is longer than the proboscis and narrower; the second joint is not very long; the claws are short, not very hairy, but armed with numerous equi-distant spines (Pl. III. fig. 10). The two mandibles are, in the three specimens procured, strongly divergent. The palpi are not very slender, nearly one-half as long as the proboscis, with the second joint not quite as long as the third, and the fifth longer than the fourth, furnished with numerous hairs at the end of the third joint, on the fourth, and on the fifth joint.

The ovigerous legs of the males (Pl. III. fig. 9) are long, more than one-half longer than the body, the fourth joint is the longest, the fifth nearly as long, all the joints are covered with very small perpendicular hairs. The spines of the four last joints are small, but numerous and elongated, sharply serrated (Pl. III. fig. 11). The claw is small, with numerous thin spines.

The ovigerous legs of the female are much shorter; 8 mm. in a female of 7 mm. The relative length of the joints is the same as in the male. The hairs are much smaller. The numbers of the denticulated spines on the four last joints are respectively 18, 17, 16, 14. There are about sixteen very slender and pointed spines at the claw.

The legs are long and slender, nearly five times as long as the body; a male of 8 mm. has legs of 38 mm. The joints are sparsely hairy, with a row of stronger hairs at the junction of two joints; the second joint is twice as long as the first; the sixth joint is by far the longest. The first tarsal joint is longer than the second, which is armed with

[1] The figures on Plate III. and IV. belonging to this species are marked, *N. armatum*, n. sp.

a row of very strong hairs placed between the thinner ones (fig. 12). The auxiliary claws are longer than half the length of the claw.

The one female specimen shows large genital openings on the second joint of every leg; the two males have the openings a great deal smaller, and only on the six hind legs. The female is immature. Its length is 7 mm., that of the males 8 mm.

Habitat.—Of this species three specimens were dredged along with *Nymphon brevicollum*, south of Halifax.

Station 49. May 20, 1873. Lat. 43° 3′ N., long. 63° 39′ W. Depth, 83 fathoms. Bottom temperature, 1·6° C. Sea bottom, gravel, stones.

Observations.—The specimens of this species have long been considered by me as closely related to, yet distinct from the *Nymphon grossipes*, O. Fabr. When I first examined this species, and made the drawings as figured on Plate III., I knew *Nymphon grossipes* only by the description of Kröyer. Since that time Mr Wilson's paper was published (March 1880), and as soon as I read his description of *Nymphon grossipes*, I almost felt sure that he had examined specimens quite identical with mine, and had rightly considered them as *Nymphon grossipes*. Lately I have had an opportunity of comparing the specimens of *Nymphon grossipes* dredged during the Challenger cruise with others, undoubtedly belonging to the same species, collected during the two cruises of the Dutch schooner "Willem Barents" in the Barents Sea. As there are, however, a few differences to be pointed out, it would perhaps be better to consider the Challenger specimens as forming a variety of this species, yet I hesitate to make such a proposal, as it is impossible to settle these questions without large collections from the same, or about the same, localities.

Nymphon brevicollum, n. sp. (Pl. III. figs. 13–15, Pl. XV. figs. 12, 13).

Diagnosis.—Body not very slender; legs slender, smooth; neck short; a small interval between the attachment of the ovigerous leg and the first true leg; intervals between the lateral processes short; oculiferous tubercle blunt; second joint of palpi longer than third, second joint of the legs longer than first and third, second tarsal joint shorter than the first. Auxiliary claws present.

Description.—The proboscis of this species is comparatively large, and nearly cylindrical. The neck is short, yet the segment formed by the conjunction of the cephalic and the first thoracic segment is tolerably large, there being also an interval (longer in the females than in the males) between the ovigerous leg and the first true leg. The abdomen is small. The oculiferous tubercle rounded and small, with four brown eyes.

The mandibles vary considerably; they often have the first joint shorter than the rostrum, the second joint comparatively long, the claws long also, armed with numerous small spines. Those of the males are more slender than those of the females.

The palpi are very slender; the first and second joints forming in the females a right

angle with the proboscis. The second joint is very long, much longer than the third. The fourth and fifth are nearly equal, shorter than the third joint, together nearly as long as the second. The hairs on the first three joints are few, on the last two numerous, closely adhering to the joints. The palpi of the males show the same length relatively to the joints, but they are more parallel with the direction of the proboscis.

The ovigerous legs are slender, only a little longer than the body in the female. The fourth and fifth joints are nearly of the same length, the sixth shorter. The four last joints are strongly bent, and describe a spiral. The denticulated spines are long and slender, their numbers being respectively 17, 14, 11, 13. The claw is very large, and furnished with numerous small spines (Pl. III. fig. 14). The first four joints are almost smooth, the number of hairs increasing from the fifth to the tenth joint, specially large hairs being placed at the end of the joints.

In the males the ovigerous legs are a great deal longer, nearly 11 mm. when the body is 6 mm.; the fourth joint is curved; the fifth forms an angle with the fourth, is very long, and shows a rudimentary articulation (Pl. XV. figs. 12, 13) at two-thirds of the length of the joint from the beginning; the sixth joint is short, but swollen; the four last joints and claw as in the female, the denticulated spines being more numerous, and respectively 19, 16, 12, 15.

The legs of the females are more than four times as long as the body (being 31 mm. long when the body is 7 mm.). The second joint is considerably swollen, as is the fourth, which contains the ovary; the fifth joint is longer and thinner than the fourth, and the sixth than the fifth. The first tarsal joint is longer than the second, the auxiliary claws are two-thirds of the length of the claw. The fourth and fifth joints are almost smooth, with the exception of some strong hairs on the fifth joint, and a row of smaller spines at the extremity. On the sixth joint the number of hairs increases towards the extremity; the two last joints have a large number of rather strong hairs.

The leg of a male of 6 mm. is about 25 mm. The leg is a great deal more slender, especially the second and fourth joints, but the relative length of the joints is the same. The auxiliary claws of the males are a great deal shorter than those of the females, their length never reaching half the length of the claw, and often being much shorter. The genital openings of the females are much larger than those of the males. In the females they are found on all the legs, in the males they are wanting on the first pair of legs.

Habitat.—With the foregoing species, south of Halifax.

Station 49. May 20, 1873. Lat. 43° 3′ N., long. 63° 39′ W. Depth, 83 fathoms. Bottom temperature, 1·8° C. Sea bottom, gravel.

Observations.—Of this species eight specimens were dredged by the Challenger. Of these five are females. Of the three males one is furnished with eggs. These specimens agree perfectly as to the relative lengths of the joints of the palpi, and of the tarsal joints of the legs, so that these characteristics are, for this species at least, really dis-

tinguishing features; these marks, together with the structure of the first segment of the body, of the oculiferous tubercle, &c., make this species one of the most sharply-characterised forms of the genus.

Nymphon brachyrhynchus, n. sp. (Pl. IV. figs. 2–7).

Diagnosis.—Body not very slender, smooth; legs hairy. Proboscis short. Mandibles large. Second joint of palpi a little shorter than third. Second tarsal joint of the leg longer than the first. Auxiliary claws small.

Description.—The body of this species is not very slender; yet there are distinct (but small) intervals between the lateral processes of the body. The proboscis is short, the segment formed by the conjunction of the cephalic and the first thoracic segment is also short, as well as the following thoracic segments. The abdomen is comparatively large and robust. The oculiferous tubercle is small and blunt, the eyes are four in number, small, and not very distinct, light brown. The body is quite smooth. The length of the female is nearly 7 mm., that of the male 6·5 mm.

The mandibles are large. The first joint is almost as long as the proboscis, the second joint curved and long, the claws long also. These claws are curved and furnished with numerous teeth; they are more numerous and smaller on the immovable than on the movable claw (Pl. IV. fig. 4). The two claws when closed meet along their whole length, the tips only crossing for a small extent.

The palpi (Pl. IV. fig. 5) are very slender, more than twice as long as the proboscis. The third joint is longer than the second, the fourth again longer than the third, the fifth much more slender, but almost as long as the second. Hairs are scarce on the second, not very numerous on the third joint, more numerous on the fourth, and very numerous on the fifth joint.

The ovigerous legs of the males are more than 10 mm. long; the fourth joint slightly, the fifth strongly curved and very long, the sixth joint short; the four last joints are short and wound up spirally. Small hairs are placed vertically on the fifth and sixth joints, larger ones at the extremity of the joints. The denticulated spines greatly resemble those of *Nymphon longicoxa*, though they are a little flatter; their numbers are respectively 13, 9, 7, 7. The spines of the claw are small and not very numerous (Pl. IV. fig. 6).

The ovigerous leg of the female is a great deal smaller: a female of 7 mm. in length has ovigerous legs of 8·5 mm. The fourth and the fifth joints especially are much shorter, and the latter are quite straight. The denticulated spines of the four last joints are more numerous than in the males; they are 14, 12, 10, 9, which numbers, however, vary slightly for the different specimens. The claw with its spines is like that of the male.

The legs are slender, those of a male of 6·5 mm. nearly 25 mm., those of a female of 7 mm. nearly as long (25·5 mm.). The second joint is more than thrice as long as the third, the fourth and the fifth nearly of the same length, the sixth almost once and a half the

length of the fifth. The two tarsal joints, of which the second is longest, describe a slight curve; the claw is large, the auxiliary claws are very small (Pl. IV. fig. 7). Beginning at the fourth joint the number of hairs regularly increases down to the end of the leg.

The legs of the females show the second and fourth joints considerably swollen. In the females the genital pores are large, and to be found on every leg; in the males they are much smaller, and occur only on the two hind pairs of legs.

Habitat.—A large number of specimens of this species was gathered in Christmas Harbour, Kerguelen. There are a great number of females with the ovaries swollen in the fourth joint of the leg; a great many males with and without eggs or larvæ on their ovigerous legs.

The specimens were dredged at a depth of 45 to 120 fathoms. (January 29, 1874. Off Christmas Harbour. Depth, 120, 105, and 45 fathoms.)

Observations.—This fine species shows very characteristic marks, and cannot easily be confounded with other species. In some respects it shows a resemblance to *Nymphon strœmii* of Kröyer.

Nymphon fuscum, n. sp. (Pl. IV. figs. 8–11).

Diagnosis.—Body and legs very slender. Cephalic segment of the body large, occasioned by the length of the so-called neck. Second joint of the palpi the longest; second joint of the leg three times as long as first; tarsal joints of leg nearly equal. Accessory claws present.

Description.—In this species the body is again extremely slender. The proboscis is short, the mouth small. Of the cephalothoracic segment the so-called neck is long, the segment itself is not very long, there being no interval between the ovigerous leg and the first true leg. Between the true legs the intervals are, on the contrary, very great. The abdomen is minute. The eyes are very large, covering almost the entire surface of the short and blunt oculiferous tubercle.

Of the mandibles, the first joint is longer than the proboscis, the second is comparatively short, and so are the claws. The movable claw is a great deal more slender than the immovable one, the latter is furnished with larger teeth, which are not so acute as the smaller ones of the movable claw (Pl. IV. fig. 9).

Of the palpi the second joint is the largest, the fourth the shortest (Pl. IV. fig. 10). The last joints are extremely hairy, but hairs are also to be found on the second and third joints. The palpi are not very long, but stout; their length being about one-half the length of the proboscis.

The ovigerous legs of the males are very characteristic, forming a very elegant curve. The fifth joint is the longest and the most strongly bent, the sixth joint is a great deal shorter, the four last joints are very short; the claw is short and furnished with very rudimentary teeth (Pl. IV. fig. 11). The spines of the four last joints are very slender,

but they are almost all broken at the extremity, their numbers are respectively 14, 14, 13, 13. On the fourth joint hairs are scarce, on the fifth there are a great many small hairs vertically implanted on the surface of the joint, the hairs of the sixth and the four last joints are also numerous: they are larger than those of the fifth joint.

The legs are very slender: in a male of 8 mm. their length is nearly 32 mm. The second joint is more than twice as long as the third, the fifth joint is only a little longer than the fourth; the sixth is once and a half as long as the fifth. The two tarsal joints are nearly equal. The claw is short, being one-third the length of the last joint of the leg. The accessory claw is not half as large as the claw. The first joints of the leg are nearly smooth, but from the sixth to the eighth they are covered with very small rough hairs.

The colour of this species is a dark brown, much darker than is the case with the other species. There are in all three specimens, of these two are mature males (one furnished with eggs), the third is a very small one with broken accessory legs. I consider it a young male. Genital pores I observed only on the second joint of the two last legs.

Habitat.—This species was found off Kerguelen Island at a depth of 25 fathoms.

Station 149. January 17, 1874. Lat 49° 40′ S., long. 70° 28′ E. Off Royal Sound. Depth, 25 fathoms.

Observations.—This species shows a certain resemblance to *Nymphon gracilipes*, Miers. Yet there are too many small differences for me to feel justified in considering the two forms as identical. The form of the oculiferous tubercle is not as figured by Böhm, the claws of the mandibles are shorter and not so straight as in *Nymphon gracilipes*, Miers (after Böhm, Pycnogon. des Museums zu Berlin, Monatsb. der K. Akad. der Wiss. zu Berlin, p. 170, 1879); the length of the fourth joint of the accessory legs is different,[1] the length of the two tarsal joints, of the claw, the colour of the whole animal, so characteristic in my *Nymphon fuscum*, is quite different from that described by Böhm (fast weiss bis hellbräunlich, Böhm, *loc. cit.*, p. 172). There can be little doubt, however, that these two forms are closely allied.

Nymphon brevicaudatum, Miers (Pl. IV. figs. 12, 13; Pl. V. figs. 1–5. *Nymphon hispidum*, n. sp., is marked on the plates).

Nymphon brevicaudatum, Miers, Ann. and Mag. of Nat. Hist., vol. xvi. p. 107, 1875; Crustacea of Kerguelen Island, Phil. Trans. Lond., vol. clxviii. (extra vol.) pp. 200–214, pl. xi. fig. 8, 1879.
Nymphon horridum, Böhm, Pycnogoniden des Museums zu Berlin, Monatsber. der K. Akad. der Wiss. zu Berlin, 1879, p. 172, taf. i. fig. 3–3*f*.

Description.—The body of this species is very robust, and has the lateral processes scarcely separated. The proboscis is comparatively short and bears a small mouth; the

[1] Böhm, *loc. cit.*, taf. i. fig. 1*d*, represents the sixth joint of the ovigerous leg as furnished with denticulated spines. Of course this is a mistake.

first segment of the body is considerably swollen at the base of the mandibles, constricted posteriorly, and shows a faint line at the beginning of the first true thoracic segment. The abdomen is comparatively long. The upper surface .of the body is armed with numerous spines, forming in the middle of the segment star-like groups (Pl. IV. fig. 12), and scattered more irregularly on the lateral processes; near the end of these a row of stronger spines is observed. The oculiferous tubercle is, especially in the females, highly elevated, and shows four dark eyes separated by a cross-like spot. The oculiferous tubercle is placed on the cephalic part of the first segment, between the two ovigerous legs.

The mandibles are very long, the first joint being much longer than the proboscis; the second joint is shorter and strongly curved, the claws being placed almost transversely before the mouth. The immovable claw is more strongly curved than the movable one; the spines on the claws are numerous, but they are almost equal and of the same length. Both joints are covered with numerous small hairs, stronger ones being found at the end of the first joint (Pl. V. fig. 2).

The palpi are not very hairy. The second joint is by far the longest, the fourth is the shortest, the fifth very slender. The whole length of the palpus is about twice the length of the proboscis (Pl. V. fig. 1).

The ovigerous legs of the males are not quite so long as the body. The fifth joint is the longest, and is considerably swollen at the extremity, the sixth joint is a great deal shorter, the seventh to the tenth joints are very short, the claw almost of the same length as the last joint. The ovigerous legs are very strongly bent and not very hairy. The denticulated spines of the four last joints are sharply serrated and not numerous, their numbers being respectively 3, 3, 2, 3 (Pl. V. figs. 3, 4). The claw is furnished with a row of acute spines.

The ovigerous legs of the females are still shorter than those of the males. The relative length of the joints is the same, but the fifth joint is not swollen at the extremity. The leg is not curved as is the case with that of the male.

For a species of *Nymphon* the true legs are uncommonly short: a female of 6 mm. has a leg of only 14 mm. The second joint is not quite twice as long as the first or third, the three following joints are almost of the same length, and comparatively robust, especially the fourth joint of the female. The two tarsal joints, the second of which is the longer, are very slender and almost smooth, together about as long as the sixth joint. The claw is about as long as one-third of the length of the second tarsal joint, the auxiliary claws are very small. The legs are very hairy. These hairs vary greatly in size and strength, and are not placed in regular rows. The dorsal surface of the leg especially is covered by a large quantity of stronger spines. The genital pores of the females are very large and visible on the second joint of every leg. Those of the males are small, and found only on the second joints of the two last legs.

I wish to point out as a very interesting peculiarity of this species, that I observed a female specimen with highly developed ovaries in the fourth joint of its legs, which bears a distinct egg-mass on its ovigerous leg. The shape of the ovigerous leg is almost identical with that of a male. In other respects it looks quite like a female.

Habitat.—This species seems to abound in the neighbourhood of Kerguelen Island. Miers (*loc. cit.*, p. 213) only says that several specimens were collected at this island, but Böhm (*loc. cit.*, p. 177) mentions specimens collected in Royal Sound, Irish Bay, and Great Whale Bay, from a depth of 15 to 65 fathoms.

The Challenger brought specimens home from Station 149. January 17, 1874. Lat. 47° 40′ S., long. 70° 20′ E. Off Royal Sound. Depth, 25 fathoms.

January 20, 1874. Royal Sound. Depth, 28 fathoms.

January 29, 1874. Off Christmas Harbour. Depth, 120 fathoms.

Observations.—After a close examination of the numerous specimens of this Pycnogonid, I at first believed it to be different from the *Nymphon horridum* of Böhm, so I gave it the name *Nymphon hispidum*, which name is still to be found on Plates IV. and V. of this Report. After a renewed examination, and having acquired, I believe, by continuous study some knowledge of the relative value of characteristic marks, I think there can be no doubt about the identity of Böhm's species and the specimens brought home by the Challenger. Unfortunately the two plates are printed off, and thus bear the name originally proposed by me.

However, the name proposed by Böhm ought also to give place to another, viz., that of Miers. The description of Mr Miers originally published was too short and insufficient, therefore Mr Böhm was quite justified in considering his specimens as distinct and proposing for them the new name *Nymphon horridum.* This happened in 1879. In the same year Mr Miers published a more detailed description with figures, which made it certain that Böhm's, Mier's, and my specimens belonged to the same species; this must, I think, bear the name originally applied to it by Mr Miers.

The latest description of this author, however, is by no means exhaustive ; his figures are very small, and when he says that the number of claws at the end of the leg is two, it is evident that he has not studied the details with a high enough power.

Böhm's description and drawings are much superior to those of Miers; they differ from mine in the following respects :—On the dorsal surface of the body he figures rows of hairs between the different segments, whereas I observed star-like groups of hairs. He gives the mandibles a much more elongated form, and furnishes the claws with very irregular teeth. On the legs, Böhm says, the hairs and spines are arranged in regular rows, whereas I failed to observe this regularity. The two tarsal joints as figured by Böhm are nearly of the same length, but I always observed that the second was much longer than the first. Minor differences in the form of the eyes, distribution of the hairs, &c., it is unnecessary to discuss. The more important ones which I have pointed out

must perhaps partly be attributed to inaccuracy; they may have been occasioned by the circumstance that Böhm's material was much more limited than mine. Böhm doubts whether he has a male example or not, whereas I had a dozen at my disposal, five of which were furnished with eggs.

Nymphon perlucidum, n. sp. (Pl. V. figs. 6–10).

Diagnosis.—Body and legs very slender, pellucid and smooth. Second joint of the palpi elongated, much longer than the third. Second joint of the feet more than twice as long as the third. First tarsal joint uncommonly short. Accessory claws.

Description.—This is a very small and a very fine species, the most transparent form of *Nymphon* I ever observed. The proboscis is robust, yet very long, much longer than the first segment of the body. There is no interval between the lateral process of the ovigerous leg and that of the first true leg, but the intervals between the other lateral processes are very large. The abdomen is small. The eyes are obsolete: a very small tubercle without pigment is all that is to be seen.

The mandibles have the first joint as long as the proboscis, the second small with very long claws, the immovable claw is strongly curved at the extremity. The number of spines on these claws is much more limited than in any of the other species of *Nymphon*, being four on the movable claw and only five on the immovable one. The mandibles are scarcely hairy: a few stronger hairs are observed at the end of the first joint, and again at the origin of the movable claw.

The palpi are not very long, once and a third as long as the proboscis. They are slender, the second joint being comparatively much longer than the third joint, and nearly as long as the three last joints together. They are covered with very small hairs.

The ovigerous legs are short: $4\frac{1}{2}$ mm. in a male of 5 mm.; the fifth joint is the longest, considerably swollen at the extremity; the sixth is a great deal shorter and feebly bent; the four last joints are very short, the claw being half the length of the last joint. The different joints are covered all over with very minute hairs. The spines of the four last joints are broad, but very small and almost show the hand form (Pl. V. fig. 9). They are not very numerous, their numbers being respectively 7, 4, 4, 5. The claw is furnished with some small spines (Pl. V. fig. 8).

The legs are slender, but not very long, only two and a half times as long as the body. The second joint is twice as long as the first and third; the fifth is longer than the fourth, and the sixth is the longest. The two tarsal joints are highly characteristic on account of the shortness of the first, and the strong spines placed along that side of the second which is opposite the claw. The length of the accessory claws is not half the length of the claw. The legs are covered with small hairs, stouter ones being placed on the fifth and sixth joints, and at the end of the joints. I have figured the two tarsal joints in fig. 10, Plate V.

The only specimen of this species collected by the Challenger is a male furnished with genital pores on the second joint of the two last legs.

Habitat.—This small species was dredged during the Challenger Expedition between Celebes and Halmahera.

Station 196. October 13, 1874. Lat. 0° 48′ S., long. 126° 58′ E. Depth, 825 fathoms. Bottom temperature, 2·4° C. Sea bottom, rock.

Observations.—This fine species is highly interesting, being among the slender species of *Nymphon,* the only one in which the form of the two last joints of the leg shows a remarkable likeness to that of the same joints of most other genera of Pycnogonida. This, however, is not the only characteristic point; a second is that the claws of the mandibles are not armed with a row of very numerous spines as in the other species of *Nymphon,* but only with three, four, or five spines. The species is blind, yet the depth from which it was brought up was only 825 fathoms, whereas *Nymphon meridionale,* Hoek, *e.g.*, lives at a depth of 1674 fathoms and has four distinct eyes.

Ascorhynchus, G. O. Sars.

Ascorhynchus glaber, n. sp. (Pl. VI. figs. 5–9; Pl. XV. fig. 16).

Diagnosis.—Proboscis one-third of the total length of the body. Abdomen half as long as the proboscis. Body and legs almost entirely smooth, with the exception of three strong spines placed dorsally on the hinder margin of the first three thoracic segments.

Description.—

Length of the proboscis,	$8\frac{1}{2}$	mm.
Length of the trunk,	$13\frac{1}{2}$	,,
Length of the abdomen,	4	,,
Total length of the body,	26	,,
Length of the cephalothoracic segment,	7	,,
Length of the third leg,	39	,,

The body of this beautiful species is strong, yet comparatively slender, with great intervals between the lateral processes. The proboscis is very stout, pyriform, distinctly triangular in transverse section; each of the three sides of the proboscis is longitudinally furrowed in the middle; at its extremity the proboscis is sharply pointed, the mouth is small and triangular. The proboscis is distinctly divided into a fore, middle, and hinder part, the latter tapering towards the extremity, where it articulates with the cephalothorax (Pl. XV. fig. 16). The length of the cephalothoracic segment is very considerable, being about half that of the trunk. Anterior to the insertion of the palpi it is a little narrower, and at the front part it bears the mandibles, between which it shows a small azygous knob. On the dorsal surface a slight elevation is observed between the two palpi, whereas behind the middle, almost exactly between the two ovigerous legs, the

same surface bears a very high conical oculiferous tubercle, which as a sense organ is quite rudimentary, being destitute of lenses, pigment, &c. A second dorsal conical elevation is found at the hinder margin of the cephalothorax, and similar very strong spines are also observed at the hinder margin of the two following thoracic segments (Pl. VI. fig. 5). At the point where these thorns arise the segments are a great deal wider than the anterior part of the following segment. The abdomen is comparatively long but very narrow, being only a little swollen at the extremity. The lateral processes for the attachment of the ovigerous legs are short, those for the true legs comparatively very long.

Both specimens of this species brought up by the Challenger are furnished with three-jointed mandibles. Those of the younger specimen bear at the extremity of the third joint slender and curved claws (Pl. VI. fig. 7); the older specimen, on the contrary, shows rudimentary straight and very small claws, the movable claw being furnished with a slender thread (Pl. VI. fig. 6). The latter specimen is a male, and there is no reason why it should not be considered as full-grown.

The form of the palpi is nearly the same as in the other species of *Ascorhynchus.* The first two joints are extremely small, the third is the longest, the fourth is short, the fifth about twice as long, and narrow in the middle, the sixth is very short; of the seventh to the tenth joints, the first is the shortest, the second the longest. With the exception of some extremely small hairs on the last joints, the surface of the palpi is quite smooth.

The ovigerous legs have the fourth joint the longest, the fifth shorter and swollen towards the extremity, the sixth about half as long as the fifth, and yet more swollen towards the extremity; of the four last joints the first is the longest, and the claw at the end of the tenth joint is extremely small. The denticulated spines are placed in different rows, each row showing spines of about the same size, whereas those of different rows vary greatly (Pl. VI. fig. 8).

Of the legs the first pair is a great deal less developed than the three following; its total length is only 30 mm., whereas that of the third pair is fully 39 mm. Of the latter leg the second joint is quite as long as the first or third joint, the fourth joint is the longest, the fifth joint is a little shorter than the fourth, the sixth again a little shorter than the fifth; of the two tarsal joints the first is a little shorter than the second, the claw is not quite half as long as the second tarsal joint. There are no accessory claws (Pl. VI. fig. 9). The claw of the first leg is extremely minute, yet distinct. The legs are almost hairless; yet the fourth and the fifth joints cannot be called smooth, as they are furnished with rows of knobs, corresponding with the knobs I observed on the leg of *Nymphon hamatum*, Hoek.

The animal from which all the above measurements, &c., are taken is a male; its genital orifices are found ventrally on the second joint of the two posterior legs. Its colour is a beautiful orange-yellow.

Habitat.—This interesting species was dredged during the Challenger Expedition at Station 146. December 29, 1873. Lat. 46° 46′ S., long. 45° 31′ E. Depth of the sea, 1375 fathoms. Bottom temperature, 1·5° C. Sea bottom, globigerina ooze.

Observations.—This species is, I believe, closely allied to *Ascorhynchus abyssi*, G. O. Sars. It can, however, easily be distinguished from that species.

1. By the proboscis, which is as long as the trunk in *Ascorhynchus abyssi*, and only two-thirds the length of the trunk in *Ascorhynchus glaber*.

2. By the lateral processes of the body, which in *Ascorhynchus abyssi*, "vix," in *Ascorhynchus glaber* are visibly longer than the breadth of the body.

3. By the oculiferous tubercle, which in *Ascorhynchus abyssi* is denticulate and placed on the fore part of the first segment, while in *Ascorhynchus glaber* it is behind the middle of the cephalothorax and quite smooth.

4. By its three-jointed mandibles.

5. By the legs, which are covered with short hairs and are twice as long as the body in *Ascorhynchus abyssi;* in *Ascorhynchus glaber*, on the contrary, they are almost smooth, and are only once and a half as long as the body.

6. By the length of the body, 10 mm. in the *Ascorhynchus abyssi*, and 26 mm. in *Ascorhynchus glaber*.

Ascorhynchus minutus, n. sp. (Pl. VI. figs. 10–16).

Diagnosis.—Proboscis not quite one-third of the total length of the body. Abdomen one-third the length of the proboscis. Body and first joints of the legs furnished dorsally with numerous strong spines.

Description.—

Length of the proboscis,	2	mm.
Length of the trunk,	3·75	,,
Length of the abdomen,	0·65	,,
Total length of the body,	6·4	,,
Length of the cephalothoracic segment,	2·3	,,
Length of the third leg,	9·0	,,

The body of this nice little species is slender, and the intervals between the lateral processes are great (Pl. VI. fig. 10). The body and legs are almost entirely smooth, single hairs being found only at the distal extremities of the joints of the legs. The proboscis is triangular, almost of the same form as that of *Ascorhynchus glaber;* it is distinctly divided into three parts, the middle part being considerably swollen. The cephalothoracic segment is comparatively long, being as long as the remaining part of the body including the abdomen. The oculiferous tubercle is situated in front of the middle of the cephalothoracic segment and is much elevated; the eyes are rudimentary. A distinct knob is

to be seen at the front margin of the segment between the origin of the two mandibles. The three following thoracic segments are short; the two middle segments are furnished like the cephalothoracic segments dorsally at their hinder margin with an elevated prickle. The lateral processes which serve for the insertion of the legs, are of considerable length; at their extremities they bear a strong prickle, which is not quite so long as those on the middle of the dorsal surface.

The mandibles consist of a single joint, bearing at its extremity a rudimentary triangular second joint.

The palpi are slender and comparatively long; the first two joints are extremely small, the third joint is the longest; the relative length of the other joints is nearly the same as in the palpi of *Ascorhynchus glaber*. The distal extremity of the fifth joint and the whole surface of the four following joints show on the one side numerous hairs of the curious form observed and described by Böhm for *Ascorhynchus ramipes*, Böhm (sp.) (*Gnamptorhynchus ramipes*, Böhm) (Pl. VI. fig. 16).

The ovigerous legs are comparatively short, 5 mm. in the specimens of 6·4 mm. The first joint is very small, the two following are a little longer, the fourth and fifth are very long, the sixth a great deal shorter; the four last joints (Pl. VI. fig. 12) are very short, and about the same length, the claw is not so extremely short as in *Ascorhynchus glaber*. The denticulated spines are placed in three distinct rows (Pl. VI. fig. 13).

The first joints of the legs are furnished dorsally with strong prickles, like those of the dorsal surface of the body and the lateral processes. The first joint of the leg is furnished with two, the second joint, which is but little longer than the first, with a single prickle. On the third joint, which is nearly as long as the first, no prickles are to be seen. The fourth is shorter than the fifth; the latter, the longest of all, is also a little longer than the sixth joint. Of the two last joints the first is a little shorter than the second (Pl. VI. fig. 14). The claw is longer than half the length of the second tarsal joint. Accessory claws are wanting. The first pair of legs, which is much feebler than the three following pairs, has a very small claw (Pl. VI. fig. 15).

Both specimens of this species collected during the cruise of H.M.S. Challenger are males. I observed small genital pores on the two hinder legs at the place which, as far as my knowledge goes, they invariably occupy. One of these males bears larvæ, for the description of which see below.

Habitat.—The specimens of *Ascorhynchus minutus* were dredged in the neighbourhood of Melbourne, at

Station 161. April 1, 1874. Off entrance to Port Philip. Depth, 38 fathoms. Sea bottom, sand.

Observations.—This species seems to be nearly allied to *Ascorhynchus ramipes*, Böhm (sp.). Yet it may be easily distinguished from it by the following characteristics:—

1. The total length of the body of *Ascorhynchus ramipes* is 11 mm., of the proboscis

3 mm., whereas the length of the body of *Ascorhynchus minutus* is only 6·4 mm., and that of the proboscis 2 mm.

2. The abdomen of *Ascorhynchus ramipes* is about as long as the proboscis, while that of *Ascorhynchus minutus* is nearly one-third the length of the proboscis.

3. On the dorsal surface the thoracic segments and the lateral processes in *Ascorhynchus ramipes* show round knobs, in *Ascorhynchus minutus* distinct prickles.

4. The four last joints of the ovigerous legs of *Ascorhynchus ramipes* are furnished with a single row of denticulated spines; those of *Ascorhynchus minutus* with three distinct rows. (I think this difference is not a real one: Böhm's observation and description will, no doubt, in this respect, be found deficient.)

5. The first true leg of *Ascorhynchus ramipes* is not furnished with a claw, that of *Ascorhynchus minutus* has a small, but distinct claw.

Ascorhynchus orthorhynchus, n. sp. (Pl. V. figs. 11–13; Pl. VI. figs. 1–4; Pl. XV. figs. 14, 15).

Diagnosis.—Proboscis almost half the length of the body. Abdomen not quite one-third the length of the proboscis. Dorsal surface with a row of prickles, also the lateral processes.

Description.—

Length of the proboscis, ...	10 mm.
Length of the trunk, ...	$9\frac{1}{2}$,,
Length of the abdomen, ...	3 ,,
Total length of the body, ...	$22\frac{1}{2}$,,
Length of the palpi, ...	14 ,,
Length of the third leg, ...	50 ,,
Length of the ovigerous leg, ...	20 ,,

The body of this species is very slender and almost smooth. The proboscis does not incline to the ventral side, and is not so much swollen as in the other species of *Ascorhynchus*, consequently the form is not pyriform, but rather club-shaped. The proboscis shows longitudinal furrows; the mouth is, as in the other species, triangular and very small (Pl. XV. fig. 14).

The cephalothoracic segment is comparatively short, being only half as long as the proboscis; the mandibles and the palpi are placed on distinct prominences. The oculiferous tubercle is elevated and conical, and furnished with four distinct eyes; the lateral processes for the ovigerous legs are very small, those for the first pair of true legs as well as those for the following legs are of considerable size. The lateral processes of the true legs are widely separated, thus contributing to the slender appearance of the whole body. Posteriorly the cephalothoracic, as well as the two following segments, are considerably elevated dorsally, while the anterior part of the following segment is much narrower,

and placed lower; these three elevations bear in their centre strong conical prickles (Pl. V. fig. 11). Similar prickles, though a little smaller, are also to be observed dorsally on the lateral processes close to the margin of the articulation with the leg.

The mandibles of the female specimen (the only one procured) are small, but distinctly three-jointed. The first two joints are extremely slender and of equal length; the third joint (Pl. VI. fig. 1) is very small, and furnished with rudiments of claws only.

The palpi are very slender, and ten-jointed. The first joint is small, the second—correctly observed by Böhm in *Ascorhynchus ramipes*—much smaller still, the third the longest of all, the fourth small, the fifth not quite half as long as the third, the sixth about the same length as the fourth, and the seventh twice as long as the sixth; the three last joints decrease regularly in length. The first four joints are nearly smooth, distinct hairs are observed towards the extremity of the fifth joint, and on the five following joints (Pl. V. fig. 13). These hairs exhibit the curious form observed by Böhm in the hairs of the palpi of *Ascorhynchus ramipes;* they are also found in *Ascorhynchus minutus* (Pl. VI. fig. 16).

The first three joints of the ovigerous legs are small, the fourth is the longest; the fifth and sixth, which are a great deal smaller, and the seventh, which is extremely small, are quite straight. The last three joints are placed at right angles to the foregoing. All the joints are almost entirely smooth, with the exception of a few hairs towards their extremities. The claw is very small. The denticulated spines on the four last joints are placed in three or four rows; their form can be understood from the drawing in fig. 3 of Plate VI.

The legs are more than twice as long as the body; the second joint is twice as long as the first, the third is as long as the first. The fourth joint is considerably swollen, the fifth nearly as long but a great deal narrower than the fourth, the sixth much narrower and a little longer also. Of the two tarsal joints the second is longer than the first and considerably curved, and the claw is nearly half as long as the second tarsal joint. The hairs on the legs are very small, and can only be seen with the microscope. Some stronger hairs are placed at the distal ends of the joints.

The single specimen brought up by the dredge is a female (having the fourth joint of the legs swollen and the ovigerous legs feeble). The genital pores are not very small, and are found ventrally at the end of the second joint of every leg (Pl. XV. fig. 15). Judging from the whole exterior of the animal, it is a full-grown, or nearly full-grown, specimen.

Habitat.—The only specimen of this species was dredged north of New Guinea, at Station 219. March 10, 1875. Lat. 1° 50′ S., long. 146° 42′ E. Depth of the sea, 150 fathoms. Sea bottom, mud.

Observations.—This curious form of *Ascorhynchus* does not show any remarkable

affinity with any of the other forms of *Ascorhynchus* described. Judging from the shape of the proboscis, it comes nearest to some of the species of *Colossendeis*. Yet in that genus the mandibles in the full-grown animal have totally disappeared, whereas *Ascorhynchus orthorhynchus* in all probability has these appendages in the adult state. I do not believe, however, as I have said before, that this difference is in reality very important, especially since I have observed among the specimens of *Colossendeis gracilis* one furnished with long three-jointed mandibles, while these appendages were totally wanting in the other specimens of the same species.

Oorhynchus, n. gen.

Diagnosis.—Proboscis ovate, inserted ventrally on the cephalothorax at a considerable distance from the front margin. Mandibles rudimentary; palpi nine-jointed. Ovigerous legs ten-jointed, the four last joints not furnished with one or more rows of denticulate spines.

Oorhynchus aucklandiæ, n. sp. (Pl. VII. figs. 1–7).

Diagnosis.—Oculiferous tubercle horizontally directed forwards. Mandibles represented by single-jointed club-shaped bodies. First tarsal joint of the legs extremely small, auxiliary claws wanting. Abdomen very long, once and a half as long as the proboscis.

Description.—

Length of the proboscis,	1 mm.
Length of the cephalothorax,	0·9 „
Length of the trunk,	2 „
Length of the abdomen,	1·5 „
Total length of the body,	4·2 „
Length of the leg,	5·5 „

This very curiously-shaped Pycnogonid has the cephalothoracic segment short but very broad, furnished at the front with a long cylindrical oculiferous tubercle which projects horizontally beyond the extremity of the proboscis. The oculiferous tubercle is furnished with four eyes, two placed dorsally, and two ventrally; the latter two are the smaller. The cephalothorax is armed at the two corners with curiously-shaped spines also projecting forwards, and above the attachment of the first pair of legs bears a couple of long hairs placed on small knobs. Similar pairs of hairs or thin spines are also observed on the two following thoracic segments on the dorsal surface between the lateral processes for the insertion of the legs. The rest of the surface of the body is entirely smooth. The three thoracic segments are small, and the lateral processes are separated by small intervals. The abdomen, on the contrary, is very long, being once and a half as long as the proboscis. The abdomen shows on both sides a row of comparatively long and projecting hairs.

The proboscis is inserted ventrally on the cephalothorax, at a considerable distance from the front margin; it is of a distinctly ovate form, and bears the small triangular mouth surrounded by slightly swollen lips.

The mandibles are represented by one-jointed robust club-shaped bodies, placed at the front margin of the cephalothorax on both sides of the oculiferous tubercle, but not reaching quite so far as that organ. The mandibles are covered all round with strong hairs, placed at right angles to the surface, and when the mandibles are viewed from below and anteriorly, the round cicatrice is observed where in all probability, at an earlier date, a second joint has been inserted.

The palpi are nine-jointed and placed close to and on both sides of the base of the proboscis. The first joint is very short, the second is the longest of all and directed forwards, the third again is short, the fourth almost as long as the second, and bent so as to form an angle with the first three joints. The fifth joint is again very short, the four last joints are nearly of the same length; the sixth, however, is the longest, and the eighth the shortest. All the joints are furnished with very strong hairs, which are longest on the third and fourth joints, and decrease in size though not in number towards the extremity of the appendages.

The ovigerous legs are strongly curved. Of the first three joints, which are not so very small as is the case in other genera, the second is the longest, being nearly twice as long as the first. The fourth and fifth joints are nearly of the same length and are the longest of all. The sixth is not quite half as long as either of the two foregoing joints; of the seventh to the tenth the first is the longest, the second much shorter and the third a little shorter, while the last joint is extremely small and may easily be overlooked. The first three joints are almost smooth, the two following are furnished with very small hairs, and the sixth to the tenth with not very numerous but longer hairs. The last joint but one is armed with one, the last with two not very strong, comparatively broad, and slightly serrated spines. The total length of the ovigerous leg is not quite so long as that of the body without the abdomen.

The legs are comparatively strong and very hairy (Pl. VII. fig. 6). The lateral processes are furnished with numerous small and curved spines; the first three joints of the leg are small and nearly of the same length. The fourth joint is twice as long as the third, and on the dorsal surface beyond the middle it bears a tubular process, directed backwards towards the origin of the leg. The fifth and sixth joints are the longest in the leg, and are nearly of the same length. The fifth joint, however, is a great deal more slender than the fourth, and the sixth much more so than the fifth. The first tarsal joint is extremely small, the second long and distinctly curved; the claw is scythe-shaped, and accessory claws are wanting. All the joints are furnished with long and strong hairs, standing at right angles to the surface; the last joints are covered with much more delicate hairs.

The only specimen of this curious species dredged by the Challenger Expedition is a male; the second joints of the two last legs bear on the ventral side distinct rounded tubercles, and at the tips of these knobs the small genital pores are to be observed.

Habitat.—*Oorhynchus aucklandiæ* was dredged at Station 169. July 10, 1874. Lat. 37° 34′ S., long. 179° 22′ E. Depth, 700 fathoms. Temperature of the bottom, 4·2° C. Sea bottom, grey ooze.

No other species of Pycnogonid was dredged at this station.

Observations.—No doubt the genus *Oorhynchus* is nearly allied to other genera of the same group, and especially to the genus *Achelia.* Although the shape of the body is widely different, we find in this genus likewise rudimentary mandibles, ovigerous legs furnished with rudimentary denticulated spines and with the four last joints, in general, almost of the same shape as those of *Oorhynchus.* In both genera the genital pores of the males are placed on tubercles situated ventrally on the second joints of the two posterior legs. They are distinguishable by the shape of the body, which is much more concentrated and rounded in *Achelia,* by the number of joints in the palpi, and by the absence of auxiliary claws from the legs of *Oorhynchus,* whereas all the species of *Achelia,* as far as is known at least, are furnished with them.

Colossendeis, Jarzynsky.

Colossendeis gigas, n. sp. (Pl. VIII. figs. 1, 2; Pl. X. figs. 1–5).

Diagnosis.—Proboscis bottle-shaped; cephalic part of the cephalothoracic segment triangular and distinct; eyes obsolete; third joint of the palpus longer than the fifth, palpus as long as the body; claws of the legs minute.

Description.—

	No. 1.	No. 2.	No. 3.	No. 4.
Length of the proboscis,	47·5 mm.	29 mm.	15 mm.	22 mm.
Length of the trunk (with the abdomen),	32·5 ,,	20·5 ,,	14 ,,	13 ,,
Length of the abdomen,	6 ,,	3·5 ,,	2 ,,	2·7 ,,
Length of the palpus,	81 ,,	53 ,,	?	38·5 ,,
Length of the ovigerous leg,	137 ,,	90 ,,	49 ,,	60 ,,
Length of the leg of the third pair,	301 ,,	211 ,,	112 ,,	143 ,,

The body of this gigantic Pycnogonid is robust; nevertheless there are distinct intervals between the lateral processes. In the large specimen (No. 1) the surface of the body is quite smooth; the palpi alone are furnished with strong hairs, and the ovigerous legs with small ones, while the extremely small hairs on the legs can only be seen with a lens. In the younger specimens the hairs are by no means so scarce. Those on the trunk, the proboscis, and the lateral processes are still very small, but the hairs on the legs are much more distinct, and, especially at the distal extremities of the joints of the legs, rows of short strong hairs may be observed; finally, the palpi and the ovigerous legs

show in these younger animals strong but not very long hairs projecting vertically from the surface.

The proboscis is bottle-shaped and very long. The lower stalk-like and more slender part (the neck of the bottle) can easily be distinguished from the middle part which is considerably swollen, whereas the anterior part is a little narrower again, but by no means so narrow as the stalk-like part. The mouth is triangular and very large. The cephalic part of the cephalothorax in this species is sharply divided from the thoracic part, the latter forming a true first thoracic segment. The cephalic part has, when viewed dorsally, a triangular shape; it bears almost exactly in the middle a very blunt oculiferous tubercle. In the younger specimens this tubercle is conical, much more elevated and pointed at the extremity; it shows neither pigment nor lenses.

The four thoracic segments are closely united, so that their terminations are not visible; the origin of the lateral processes for the insertion of the legs is, on the contrary, distinctly marked by a line.

The abdomen is club-shaped and not longer than $\frac{1}{13}$th of the total length of the body. As in the other species of the genus *Colossendeis* it is connected with the thorax by means of an articulation.

The palpi are as long as, or a little longer than, the body. The two first joints are extremely small, the third is very long, the longest of all the joints of the palpi; it is a little swollen at its beginning and again at the extremity. The fourth joint is again very small, the fifth almost as long as the third; the sixth is again much shorter, nearly one-fourth the length of the fifth. Of the last four joints the seventh is the longest, the eighth being only half its length, and the ninth and tenth, which are of equal length, being still shorter than the eighth. The first four joints are almost quite smooth, while the following joints are furnished with short but rather strong hairs.

The ovigerous legs, as in the other species of this genus, are attached close to the base of the palpi. The lateral processes for the ovigerous legs are found at the ventral side, immediately behind and close to the first joint of the palpi. The first three joints of the ovigerous legs are extremely short, not longer than they are broad. The fourth joint is very long (almost as long as the proboscis) and not inconsiderably swollen at the extremity. The fifth joint is again short, and this joint serves—as was observed by Wood-Mason[1]—to elbow the ovigerous leg. The sixth is still longer than the fourth and exactly as long as the proboscis. The last four joints gradually become more slender; they are nearly equal in length and very short, the length, however, decreases a little from the seventh to the tenth joint. At its extremity the last joint bears a very small hook-like curved claw, the inner surface of which is quite smooth.

[1] Wood-Mason, On *Rhopalorhynchus kröyeri*, Journ. of the Asiatic Soc. of Bengal, Calcutta, vol. ii., 1873.

The last four joints describe a spiral curve; so that the tenth lies parallel to the seventh. Their inner surfaces are furnished with numerous rows of very flat spines. In the oldest specimen there are about twelve rows, making the total number of spines for every joint several hundreds. None of these spines, however, show the original shape; they are all of them broken by use or by age, and those placed towards one side especially are very short and rudimentary. On the other side they grow longer (Pl. X. fig. 2), and, covered by this outermost row of longest spines, some short thimble-shaped knobs (fig. 5) are to be observed. Such is at least the condition of the flattened spines on the last four joints of the ovigerous legs of the gigantic male dredged at Station 146. The specimen second in size is a great deal smaller and in all probability is not quite adult. Here the spines, placed in about eight rows, show a much more regular shape (fig. 3); their margins are furnished anteriorly with very small hairs. These hairs are rather firm, are not at all injured by the action of alcohol, and must not, I believe, be considered as cilia. The spines are in the middle a great deal narrower, and broader again at the extremity, the broader part has the shape of a rhomb. In the earliest stage the spines are much smaller and beautifully spatulate. The small hairs extend here to beyond the middle (Pl. X. fig. 4).

This species has exceedingly long legs. The first three joints are very small, the three following very long; the fourth is the longest, the fifth a little shorter, the sixth again a little shorter; the two last joints are small again; the second tarsal is only half as long as the first. The claw measures about one-third the length of the second tarsal joint; there are no auxiliary claws. The joints of the leg, from the fourth to the eighth, gradually decrease in thickness. The hairs, which on the legs of the large adult specimen are extremely small and sparse, are stronger and more numerous on the legs of the younger specimens.

In regard to the sexes of the specimens of this species dredged during the voyage of the Challenger, I am sure only of the gigantic specimen. This is a male; it shows genital openings on the ventral surface not very close to the distal margin of the second joint of the two posterior pairs of legs. About the other specimens, whose genital openings I failed to observe, I am in doubt whether they are young males or females. The colour of the specimens is light yellow, nearly the same as that of all other Pycnogonids preserved in spirits. The large full-grown male, however, is of a much darker orange-red colour, with beautiful red bands over the proboscis, at the extremity of the joints of the legs, &c.

Habitat.—*Colossendeis gigas*, seems to occur in different parts of the southern ocean; it was dredged at

Station 146. December 29, 1873. Lat. 46° 46′ S., long. 45° 31′ E. Depth of the sea, 1375 fathoms. Temperature of the bottom, 1·5° C. Sea bottom, globigerina ooze.

Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E. Depth of the

sea, 1600 fathoms. Temperature of the bottom, 0·8° C. Sea bottom, globigerina ooze.

Station 300. December 17, 1875. Lat. 33° 42′ S., long. 78° 13′ W. Depth 1375 fathoms. Bottom temperature, 1·5° C. Sea bottom, globigerina ooze.

Of all the species of this genus known at present, this species of *Colossendeis* shows by far the greatest affinity with *Colossendeis leptorhynchus*, which I shall describe further on. The latter species, however, is much more slender.

Colossendeis leptorhynchus, n. sp. (Pl. VIII. figs. 3–7).

Diagnosis.—Proboscis almost cylindrical. Cephalic part of the cephalothoracic segment distinctly separated from the thoracic part; eyes obsolete; third joint of the palpus shorter than the fifth; palpus much longer than the body. Legs and proboscis extremely slender. Claws of the legs minute.

Description.—

	Male.	Female.
Length of the proboscis,	28 mm.	33 mm.
Length of the trunk with the abdomen,	13 „	14 „
Length of the abdomen,	2·2 „	2·5 „
Length of the palpus,	35 „	37 „
Length of the ovigerous legs,	56 „	57 „
Length of the leg of the third pair,	143 „	158 „

The body, and especially the proboscis and legs, are a great deal more slender than in *Colossendeis gigas*. The intervals between the lateral processes are not quite so wide as the thickness of these processes. The surface of the body is quite smooth, but the palpi and ovigerous legs, and the last five joints of the legs, are furnished with extremely small hairs.

The proboscis is extremely long, more than twice as long as the trunk; about the middle it is slightly swollen. The cephalic part of the cephalothorax is distinctly separated from the thoracic part. It is elongated, a little more slender towards the end, and bears on the dorsal surface, about the middle, a small blunt knob as a rudimentary oculiferous tubercle.

The four thoracic segments are closely united. The abdomen is small, about 1-18th of the total length of the body. The palpi are not very long. The first two and the fourth joints are extremely small; the third is long, and the fifth a great deal longer still. The sixth joint is shorter than the seventh, and of the last three joints (fig. 5), the third is by far the longest. The relative lengths of the joints of the ovigerous legs is the same as in *Colossendeis gigas*, Hoek; the sixth joint is again considerably longer than the fourth, and the fifth is extremely short. The last four joints decrease in length, and the claw is very small (fig. 6).

The first three joints of the legs are very small, nearly as long as broad; the following

three are very long and slender, and not inconsiderably curved. Their relative length is the same as in *Colossendeis gigas*. Of the last two joints, the first is longer than the second. The claw is small.

Of this species seven adult and two young specimens were dredged during the cruise of H.M.S. Challenger. By stretching out the legs parallel with each other, the body of the animal assumes a very peculiar aspect.[1] Of the eight adult specimens, seven are females—one only a male. Both the females and the male have genital openings only on the two hindermost legs, where they are placed on the ventral surface of the second joint of the leg. Perhaps the ovigerous legs of this species, and in that case probably of the other species of this genus also, have lost their egg-bearing function. Small capsules filled with numerous eggs were attached to several joints of the legs, but as these eggs were quite undeveloped, it was impossible to determine whether they belong really to this animal, or to some other inhabitant of the same locality. The capsules, I observed, were attached to the fourth joint of the leg in a female, and to the second joint of the leg in the single male specimen.

Habitat.—This species was dredged at the same stations as the foregoing species (*Colossendeis gigas*), and also at a fourth station (310).

Station 146. December 29, 1873. Lat. 46° 46′ S., long. 45° 31′ E. Depth of the sea, 1375 fathoms. Temperature of the bottom, 1·5° C. Sea bottom, globigerina ooze.

Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E. Depth of the sea, 1600 fathoms. Temperature of the bottom, 0·8° C. Sea bottom, globigerina ooze.

Station 300. December 17, 1875. Lat. 33° 42′ S., long. 78° 13′ W. Depth of the sea, 1375 fathoms. Temperature of the bottom, 1·5° C. Sea bottom, globigerina ooze.

Station 310. January 10, 1876. Lat. 51° 30′ S., long. 74° 3′ W. Depth of the sea, 400 fathoms. Temperature of the bottom, 7·9° C. Sea bottom, mud.

Observations—This species is distinguished from the foregoing by its much more slender form and shorter palpus. From *Colossendeis angusta*, G. O. Sars (Arch. f. Math. og Naturvid., vol. ii. p. 268, 1877), and other species, it may be easily distinguished by the dimensions of the joints of the palpus; for, as far as I know, *Colossendeis leptorhynchus* is the only species of this genus which has the fifth joint of the palpus considerably longer than the third. The form of the cephalic part of the cephalothorax, and the extremely small claws at the ends of the legs indicate, I believe, a near relationship between this species and *Colossendeis gigas*.

Colossendeis gigas-leptorhynchus.

A single specimen—unfortunately defective—dredged at Station 158, shows to a

[1] This, of course, refers to the animal preserved in spirits. I observed the same thing in living specimens of *Nymphon gracile*, Leach, and *Pallene brevirostris*, Johnston.

certain extent the characteristics of *Colossendeis gigas*, and in other respects those of *Colossendeis leptorhynchus.* I therefore wish to consider it as an intermediate form. Its dimensions are as follow :—

Length of the proboscis, ...	26 mm.
Length of the trunk with the abdomen, ...	18 ,,
Length of the palpus, ...	$33\frac{1}{2}$,,
Length of the ovigerous leg, ...	?
Length of the leg, ...	137 ,,

As I consider that this specimen is not quite adult, I will not give a detailed description of it. I only wish to point out that the form of the proboscis, though a little more slender, quite agrees with that of *Colossendeis gigas*, whereas the relative length of the joints of the palpus, and that of the whole palpus, is the same as in *Colossendeis leptorhynchus*, viz., the third joint of the palpus is 8·5 mm., and the fifth 14 mm. The total length of the palpus is only three-quarters the length of the body.

The specimen is a young female, with the body almost smooth, and with legs only furnished with extremely small hairs.

Habitat.—This curious form was dredged at Station 158. March 7, 1874. Lat. 50° 1′ S., long. 123° 4′ E. Depth of the sea, 1800 fathoms. Bottom temperature, 0·3° C. Sea bottom, globigerina ooze.

Colossendeis robusta, n. sp. (Pl. IX. figs. 4, 5).

Diagnosis.—Proboscis club-shaped, shorter than the trunk. Body and legs rather stout, with large intervals between the lateral processes for the insertion of the legs. Palpi not very long, a great deal shorter than the body, with the third joint longer than the fifth. Legs not very slender, furnished with a claw, which is almost half as long as the second tarsal joint. Oculiferous tubercle conical, with four eyes.

Description.—

Length of the proboscis, ...	15 mm.
Length of the trunk with the abdomen, ...	18 ,,
Length of the abdomen, ...	3·5 ,,
Length of the palpus, ...	25 ,,
Length of the ovigerous legs, ...	52 ,,
Length of the leg of the third pair, ...	113 ,,

Only a single specimen of this beautiful and robust form was dredged. All the segments of the body are closely united, the cephalic part is comparatively short, and bears a conical, robust, not much elevated, oculiferous tubercle. This tubercle shows four distinct eyes, two of which are large and directed forwards, while the two small ones are directed backwards.

The intervals between the well-developed lateral processes are comparatively large. The proboscis is not quite half so long as the total length of the body. It is very stout, and shows a considerable swelling in the middle, and another at the extremity. The abdomen is small, its length about one-fifth the length of the trunk.

The palpi are comparatively stout, shorter than those of *Colossendeis gigas*, but longer than those of *Colossendeis leptorhynchus.* The first two joints are very small, the third is by far the longest of all the joints. The fourth is short again, the fifth only three-fourths as long as the third, the sixth to the tenth are nearly of the same length, the seventh, however, is a little longer. The joints are almost perfectly smooth, with the exception of some very small hairs visible only with the microscope.

The ovigerous legs have the first three joints short, the fourth and sixth of about the same length, and comparatively long. The fifth (the elbow-joint) is short. The four last joints are almost of the same length, becoming more slender from the first to the fourth. The claw is small and smooth; the place of the denticulate spines of the four last joints is filled up by short strong knobs of a conical or rounded shape. They are placed on excavations of the chitinous skin, and with the exception of the two rows on one side, are placed rather irregularly.

The legs are not very long. Those of the third pair are the longest. The first and the fourth leg of the right side are, in the Challenger specimen, quite rudimentary. In the full-grown leg the fourth and the sixth joint have the same length, whereas the fifth is a little shorter. Of the two tarsal joints the first is longer than the second. The claw is robust, about half as long as the second tarsal joint.

The only specimen brought home by the Challenger Expedition is a female. Its genital openings are not very large, and are found ventrally on the second joint of all the legs.

The animal is entirely smooth, and of a beautiful orange colour.

Habitat.—This species was dredged off Christmas Harbour, Kerguelen, 29th June 1874. Depth of the sea, 120 fathoms.

Observations.—This species cannot easily be confounded with any of the other species; it is distinguished by being stout, yet comparatively slender, by the form of the proboscis, and the presence of four distinct eyes. It is rather a shallow-water species.

Colossendeis megalonyx, n. sp. (Pl. IX. figs. 1–3).

Diagnosis.—Proboscis club-shaped, somewhat bent over to the ventral side. Cephalic part of the cephalothorax not distinctly separated. Oculiferous tubercle conical, with four eyes. Third joint of the palpus longer than fifth. Body and legs slender. Claws of the legs as long as the second tarsal joint.

Description.—

Length of the proboscis,	20 mm.	8 mm.	13·5 mm.	17·5 mm.
Length of the trunk,	10·5 „	8 „	8 „	10·5 „
Length of the abdomen,	2·5 „	2 „	1·5 „	2 „
Total length of the body,	33 „	...	...	...
Length of the palpus,	26 „	...	...	...
Length of the ovigerous leg,	39 „	...	...	...
Length of the leg of the third pair,	97 „	...	...	...

The proboscis of this species is club-shaped, a little bent over to the ventral side; longer than the trunk with the abdomen. The cephalothoracic segment is comparatively small and not distinctly divided into a cephalic and a thoracic part. Between the lateral processes of the thoracic joints large intervals are to be observed. The oculiferous tubercle is large and high, conical, furnished with four eyes. Of these, two are very large and directed forwards, while the two directed backwards are a great deal smaller and in all probability are rudimentary. The abdomen is small, only 1-13th of the total length of the body.

The palpi are slender, and the lengths of their joints are not very characteristic. The third joint is much longer than the fifth, and of the three last joints the eighth is very small, the ninth and tenth considerably longer. In the ovigerous legs the fourth and sixth joints have nearly the same length, while the fifth is not quite half as long. The four last joints are small, and nearly equal in length, growing however a little shorter and more slender towards the tenth joint. The claw is very short.

The distribution and form of the denticulate spines is in this species very characteristic. There are two rows of comparatively long and flat spines, the margins of which show when greatly magnified very minute hairs; in addition to these two rows a moderate number of smaller flattened spines are found scattered over that side of the four last joints which is bent inwards. I have figured these two rows and the irregularly placed spines in figure 3 on Plate IX.

The legs are not very long, nearly three times as long as the body in the adult specimen, while the younger specimens have them much shorter. The three first joints are very short, the fourth is the longest, viz., 23 mm.; in a leg, the fifth joint of which measures 21 mm., the sixth is 18 mm. The two tarsal joints are together as long as the sixth joint. The claw is large, almost as long as the second tarsal joint.

The surface of the body and of the legs is almost entirely smooth. The palpi show only very small hairs, and on the ovigerous legs hardly any hairs are to be observed.

Of this species seven specimens were dredged. They are, I think, all young ones with the exception of one specimen which is a male. It shows genital pores ventrally on the second joint of all the legs.

Habitat.—This specimen was dredged at the following stations:—

Station 149. January 29, 1874. Off Christmas Harbour, Kerguelen. Depth of the sea, 120 fathoms.

Station 313. January 20, 1876. Lat. 52° 20′ S., long. 68° 0′ W. Depth of the sea, 55 fathoms. Temperature of the bottom, 8·8° C. Bottom of the sea, sand.

Station 314. January 21, 1876. Lat. 51° 36′ S., long. 65° 40′ W. Depth of the sea, 70 fathoms. Temperature of the bottom, 7·8° C. Bottom of the sea, sand.

Observations.—This species resembles *Colossendeis proboscidea*, Sab., sp. (Appendix to the Supplement of Captain Parry's Arctic Voyage, 1824, p. ccxxvi.), in the form of the proboscis. That species, however, is a great deal stouter, and has a much larger body with comparatively short legs. Moreover, the body of *Colossendeis proboscidea* is rather disc-shaped, and by no means so slender as that of *Colossendeis megalonyx.* This species ranges from Kerguelen as far west as the east coast of Patagonia; the three stations, however, at which it was found are nearly under the 50th parallel.

Colossendeis gracilis, n. sp. (Pl. IX. figs. 6–8; Pl. X. figs. 6, 7).

Diagnosis.—Body slender, with wide intervals between the lateral processes; proboscis about as long as the trunk; palpus once and a half as long as the proboscis, with the third joint longer than the fifth, the eighth joint extremely small, and the ninth joint laterally inserted on the front of the foregoing. Ovigerous legs about once and a half as long as the total length of the body. The claw of the legs longer than the second tarsal joint. Oculiferous tubercle conical, without eyes.

Description.—

Length of the proboscis,	6·5 mm.	5·8 mm.
Length of the trunk,	6 „	5·2 „
Length of the abdomen,	1·5 „	1 „
Total length of the body,	14 „	12 „
Length of the palpus,	9·5 „	9 „
Length of the ovigerous leg,	22 „	19·5 „
Length of the leg of the third pair,	51 „	40 „

The proboscis of this species is nearly as long as the trunk, and a little shorter than the trunk with the abdomen. It is a little swollen nearly in the middle, but in some specimens it is almost quite cylindrical. The cephalothoracic segment has the cephalic part, which is rather triangular, in some degree distinct. It bears anteriorly the very high conical oculiferous tubercle.

The lateral processes for the insertion of the legs are widely separated. The abdomen is not very short, and in one of the specimens is a little more swollen at the extremity than in the others.

Mandibles (Pl. X. fig. 6) are present in one of the specimens. It is a young male:

the largest specimen, however, of this species dredged. These mandibles are very long and slender, three-jointed, little shorter than the proboscis. The third joint terminates in a pair of small and slender pincers.

Of the palpi the third joint is longer than the fifth. Of the last three joints the first is extremely small and broad (Pl. IX. fig. 7), and the ninth is inserted, not into the middle of the front part of that joint, but quite laterally. This ninth joint itself is cylindrical, and more than twice as long as the foregoing, whereas the tenth is a little more slender and still longer than the ninth joint.

The joints of the comparatively long ovigerous legs have characteristic proportions in all the species of the genus *Colossendeis*. The claw at the end of the tenth joint is very small. The denticulate spines on the last four joints are not numerous, the number of rows not exceeding four. Of these two are very regular, with the spines placed close to one another, but those of the two other rows are much more irregularly scattered over the remaining part of the inner surface of the joint (Pl. IX. fig. 8; Pl. X. fig. 7).

The lengths of the several legs of one and the same specimen only show slight differences. The third leg is, in the three specimens I have examined, the longest, and measures nearly three and a half times the length of the body. The claw is very long, still longer than the second tarsal joint. Genital pores are present on the second joint of every leg. As to the sex of the three specimens dredged during the voyage of H.M.S. Challenger, I have only been able to ascertain that the specimen with mandibles is a male.

The body and legs are almost entirely smooth; small hairs are only to be observed on the last joints of the palpi.

Habitat.—This species was dredged between the Cape of Good Hope and Kerguelen Island.

Station 146. December 29, 1873. Lat. 46° 46′ S., long. 45° 31′ E. Depth of the sea, 1375 fathoms. Temperature of the bottom, 1·5° C. Bottom of the sea, globigerina ooze.

Station 147. December, 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E. Depth, 1600 fathoms. Bottom temperature, 0·8° C. Bottom of the sea, globigerina ooze.

Observations.—To this species *Colossendeis media* and *Colossendeis brevipes*, which I shall describe further on, are closely allied. The occurrence of mandibles in one of the specimens of this species is very interesting. Although larvæ of any species of *Colossendeis* have never been observed, they doubtless are furnished with three pairs of cephalic appendages. Of these the adult animal has always lost the first pair; and whenever, as in the case in question, this first pair is observed in the adult animal, it must be considered as a case of atavism, showing that the loss of mandibles in the adult animal has been comparatively recent.

Colossendeis media, n. sp. (Pl. X. figs. 10, 11).

Diagnosis.—Palpi more than once and a half the length of the proboscis; ninth joint not attached laterally to the eighth; together they are as long as the tenth joint. Denticulate spines of the four last joints of the ovigerous legs in five distinct rows. Legs not quite three times as long as the body. Otherwise this species resembles the foregoing.

Description.—

Length of the proboscis,	$7\frac{1}{2}$ mm.
Length of the trunk,	$6\frac{1}{2}$,,
Length of the abdomen,	$1\frac{1}{2}$,,
Total length of the body,	$15\frac{1}{2}$,,
Length of the palpus,	12 ,,
Length of the ovigerous leg,	20 ,,
Length of the leg of the third pair,	$45\frac{1}{2}$,,

This species is nearly of the same shape and the several parts show almost the same proportions as in *Colossendeis gracilis*, Hoek. The only differences are the following:—

1. The palpi are longer, and of the three last joints the very small eighth joint does not bear the following joint laterally, but quite in front (Pl. X. fig. 10).

2. The denticulate spines of the ovigerous legs (of the four last joints) are placed in five distinct rows. They are small with the exception of those of the outermost row, which are a great deal larger. These spines have the flattened shape of those of other species of *Colossendeis*. Those which are not broken, show on the margin very small hairs.

3. The legs are not quite thrice as long as the body, The fourth joint is twice as long as the sixth. The claw is longer than the second tarsal joint. The two tarsal joints are about the same length, together they are as long as the body.

The body and legs are almost entirely smooth; when seen with the microscope very short hairs are to be observed; those on the palpi are a little stronger. On the second joint, on the ventral surface, of every leg very small genital pores are to be observed. However, as the two specimens of this species probably are not quite adult, I could not determine to which sex they belong.

Habitat.—This species was dredged at Station 298. November 17, 1875. Lat. 34° 7′ S., long. 73° 56′ W. Depth of the sea, 2225 fathoms. Bottom temperature, 1·3° C. Bottom of the sea, grey mud.

Observations.—This species is nearly allied to *Colossendeis gracilis*. However, as the differences I have pointed out are present equally in both specimens I cannot consider them identical with that species.

Colossendeis brevipes, n. sp. (Pl. X. figs. 8, 9).

Diagnosis.—Lateral processes not very widely separated. Palpus less than once and a half as long as the proboscis, with the three last joints bent over like a hook. Ovigerous legs with the denticulate spines of the four last joints numerous and comparatively short. Length of the legs unequal, short. Otherwise this species resembles *Colossendeis gracilis*, Hoek.

Description.—

Length of the proboscis,	9 mm.	8·5 mm.
Length of the trunk,	7·5 ,,	7·5 ,,
Length of the abdomen,	2·5 ,,	2 ,,
Total length of the body,	19 ,,	18 ,,
Length of the palpus,	12 ,,	11·5 ,,
Length of the ovigerous leg,	29 ,,	25 ,,
Length of the leg of the first pair,	50 ,,	54 ,,
Length of the leg of the second pair,	62 ,,	77 ,,
Length of the leg of the third pair,	53 ,,	62 ,,
Length of the leg of the fourth pair,	45 ,,	52·5 ,,

This true deep-sea species is also nearly allied to *Colossendeis gracilis*. The first time I examined it I was struck with the shortness of the legs, especially in the largest specimen; but as it is possible that this length varies greatly under different circumstances—as it certainly does with age—it is necessary to use the utmost care in judging of this characteristic mark. The body, proboscis, trunk, and abdomen are as in *Colossendeis gracilis*, the only difference being that the lateral processes are not quite so widely separated.

The palpus is short, only one-fourth as long as the proboscis. The last three joints are extremely short, shorter than the seventh joint; they are bent like a hook, the tenth joint hanging down parallel with the seventh joint (fig. 8).

The ovigerous legs are comparatively long, 29 mm. in a specimen of 19 mm. The last four joints are small and furnished with a rudimentary claw, the length of which is nearly one-fifth the length of the tenth joint. A drawing of the denticulate spines on one of the four last joints of the ovigerous leg is given in fig. 9. The spines are short and flat and do not show small hairs at the periphery. There are two regular rows, the outermost of which has the stoutest and longest spines, whereas the irregularly placed spines on the other side decrease in size. The length of the legs is very unequal. The specimen with the shortest legs is a full-grown female. The claw at the end of the eighth joint is very long, longer than that joint. The body and legs are almost entirely smooth; there are small hairs on the last joints of the palpi.

The genital pores of both specimens, the largest of which is a female, are found ventrally on the second joint of all the legs.

Habitat.—This species was dredged from the greatest depth at which a Pycnogonid has been found, viz., 2650 fathoms.

Station 325. March 2, 1876. Lat. 36° 44′ S., long. 46° 16′ W. Depth of the sea, 2650 fathoms. Bottom temperature, 70·4° C. Bottom of the sea, grey mud.

Observations.—Whether I am right or not in considering the specimens collected at Stations 146 and 147 (*Colossendeis gracilis*, Hoek), Station 298 (*Colossendeis media*, Hoek), and Station 325 (*Colossendeis brevipes*), as three different species can only be ascertained by examining a larger number of specimens than are at my disposal. I can only point out here the great affinity of these different specimens. However, I may be permitted to state here, that whenever I speak of a specimen as adult, the statement is based on the microscopical examination of transverse sections of the fourth joint of one of the legs.

Colossendeis minuta, n. sp. (Pl. X. figs. 12–14).

Diagnosis.—Proboscis cylindrical, once and a half the length of the trunk with the abdomen. Lateral processes not widely separated. Palpus once and a half as long as the proboscis, with the last three joints of about the same length. Legs extremely slender, about four and a half times the length of the body. Claw of the leg half as long as the second tarsal joint.

Description.—

Length of the proboscis, ...	4·8 mm.
Length of the trunk, ...	2·7 ,,
Length of the abdomen, ...	0·5 ,,
Total length of the body, ...	8 ,,
Length of the palpus, ...	7·5 ,,
Length of the ovigerous leg, ...	14 ,,
Length of the leg of the third pair, ...	35 ,,

Only a single specimen of this species was dredged. It is a small animal with a comparatively long proboscis and very slender legs. The body is not extremely slender, there being only small intervals between the lateral processes for the insertion of the legs. The cephalothoracic segment is small and not distinctly divided into a cephalic and a thoracic part. Quite near the front it is furnished with a blunt oculiferous tubercle without eyes.

The proboscis is nearly cylindrical, it is a little swollen in the middle, and the mouth is small and triangular. The abdomen is small; it is connected with the last thoracic joint by a true articulation.

The palpus is slender, but not extremely long, being only once and a fourth as long as the proboscis. The third joint is only a little longer than the fifth. I have given a drawing of joints six to ten in fig. 13. The last three joints together are longer than the seventh; they are of about the same length, and comparatively slender. Beginning with the fifth, all the joints are furnished with short but strong hairs, which have the same shape as those on the legs and ovigerous legs.

The ovigerous legs are of the ordinary form. Only the middle of that part of the surface of the four last joints which is turned inwards, is furnished with denticulate spines. Their form is very peculiar, being flattened and much broader towards the extremity (Pl. X. fig. 14). They are not very numerous and are placed in three rows only, while every row contains about six of them. The margin of the spines is smooth. The claw of the ovigerous leg is small, and the length of the several joints is as in the other species of the same genus.

The legs are extremely long and slender. With the exception of some small but strong hairs, like those of the palpus, they are smooth. The first three joints are small; of the three following the first two (the fourth and fifth) are nearly of the same length, whereas the sixth is considerably shorter, but much longer than the last two joints together. Of these the first (the first tarsal joint) is about once and a half as long as the second. The claws at the ends of the legs are about half as long as the second tarsal joint.

About the sex of the only specimen collected I am unable to form an opinion. Perhaps it is not yet quite adult: extremely small genital pores are to be observed ventrally on the second joint of every leg.

Habitat.—This interesting little *Colossendeis* was dredged by the Challenger at

Station 50. May 21, 1873. Lat. 42° 8′ N., long. 63° 39′ W. Depth of the sea, 1250 fathoms. Temperature of the bottom, 2·8° C. Bottom of the sea, grey ooze.

Observations.—This curious form is intermediate, I believe, between the short-nailed *Colossendeis leptorhynchus*, with its extremely long proboscis, and the long-nailed *Colossendeis gracilis*, with the comparatively short proboscis. The difference in length between the third and the fifth joint,—in *Colossendeis leptorhynchus* the fifth joint is the longest, and in *Colossendeis gracilis* it is the third joint which has the advantage—has almost disappeared in *Colossendeis minuta*.

The species was dredged about two degrees south of Halifax; though the Pycnogonids of the neighbourhood of the coast of New England are comparatively well known, the occurrence of a species of *Colossendeis* in those regions has not been recorded as yet. And this, no doubt, is due to the circumstance that the species in question inhabits deep water, while hitherto only the shallow water inhabitants have been carefully investigated.

Discoarachne, n. gen.

Diagnosis.—Proboscis stout, cylindrical, tapering towards the extremity. Mandibles wanting. Palpi five-jointed. Ovigerous legs not furnished with denticulate spines, ten-jointed.

Discoarachne brevipes, n. sp. (Pl. VII. figs. 8–12).

Diagnosis.—Body disciform, consisting of the true body without any segmentation

and the closely united lateral processes. Legs short with auxiliary claws. Body and legs smooth, furnished only with very small hairs.

Description.—

Length of the proboscis,	$2\frac{1}{8}$ mm.
Length of the abdomen,	$1\frac{1}{4}$ „
Total length of the body,	$4\frac{1}{4}$ „
Length of the palpi,	$1\frac{1}{2}$ „
Length of the ovigerous legs,	$2\frac{3}{8}$ „
Length of the legs,	7 „

The cephalothoracic joint is closely connected with the three other thoracic joints; the lateral processes are short and somewhat triangular, forming in connection with the body a disciform surface, from which the legs radiate in different directions. The proboscis is comparatively large, the form cylindrical, tapering towards the extremity. The oculiferous tubercle, which is small, not very elevated, and furnished with four distinct eyes, is placed dorsally on the middle of that part of the body, which corresponds with the cephalothoracic segment.

The palpi are small, measuring about two-thirds the length of the proboscis. The first and second joints are very short, the third joint is the longest of all, the fourth again small, the fifth more than twice as long as the fourth, and comparatively slender. The first two joints are smooth, the third joint is furnished up to the outer margin with three long spines, and on its inside with three smaller spines, which are curved; the ventrally directed surface of the same joint, which contains a large gland, hereafter to be described, has, near the middle, four extremely small spines. The fourth joint is nearly smooth, the fifth is armed with very large and numerous spines near the extremity.

The first joint of the ovigerous legs is very small, the second and the third are a little longer, the fourth and the fifth are the longest, the sixth is short again, the seventh, eighth, ninth, and tenth are about the same length, and gradually diminish slightly in breadth. The first five joints are nearly smooth, towards the distal extremity the sixth shows some short and not very strong spines, whereas the four following joints are furnished in the same place with much stronger and slightly curved spines. Towards the end of the tenth joint there are a considerable number of these spines, while a claw and true denticulate spines are totally wanting.

The first three joints of the legs are small; of the three following, the middle joint is the longest. The first tarsal joint is extremely short, the second comparatively long, and very slender in comparison with the other joints of the legs. The claw is about one-third the length of the second tarsal joint. The auxiliary claws are comparatively long, two-thirds the length of the claw. The hairs on the different joints of the legs are small; the distal extremity of these joints is, as a rule, furnished with a row of longer and stronger spines, especially at the end of the sixth joint. The first tarsal joint has

numerous small hairs on the inner margin; the second is armed with three very strong and broad spines on the inner margin near the base, while longer and much more slender spines are present on the outer margin.

A single specimen of this species was collected during the cruise of H.M.S. Challenger. It is a female with eggs in all stages of ovarian development, enclosed in the fourth joint of the leg. The genital pores I could not distinctly observe, but no doubt they are placed ventrally near the distal extremity of the second joint of the leg.

Habitat.—This species was found at Seapoint near Cape Town in November 1873.

Observations.—The genus *Discoarachne* is in all probability nearly allied to *Endeis*, Philippi. But as that genus is difficult to make out from the insufficient description of Philippi, I propose a new genus for the species in question, because Philippi's form had eight-jointed palpi, whereas the Challenger form, which must be a full-grown animal, has only five-jointed palpi. This species with its short legs and highly concentrated body, is a true littoral form.

Pallene, Johnston.

Pallene australiensis, n. sp. (Pl. XI. figs. 1–7).

Diagnosis.—Body extremely slender. Cephalic part of the cephalothoracic segment distinctly separated from the thoracic part by means of a true articulation. Proboscis short, inserted ventrally. Ovigerous legs with true denticulate spines, and a long denticulate claw. Legs without auxiliary claws.

Description.—

Length of the proboscis,	1·5 mm.
Total length of the body,	6·5 "
Length of the ovigerous legs,	7 "
Length of the leg of the third pair,	28 "

The body is extremely slender; the cephalic part of the cephalothoracic segment (neck) is much swollen at the tip for the insertion of the mandibles. A true articulation divides this cephalic part from the thoracic part. The rather short oculiferous tubercle is situated about the front of the thoracic part.

The intervals between the lateral processes, at the extremities of which the legs are found, are very large. The abdomen is rudimentary and directed a little upwards. The surface of the body and of the lateral processes is smooth. The proboscis is short and inserted rather ventrally. It is constricted beyond the middle, and is much wider at the extremity, where the very small triangular mouth is observed.

The mandibles are short and robust. The first joint reaches almost as far as the end of the proboscis, the second joint is considerably swollen, and terminates in a pair of short pincers. These are furnished with a single very small tooth towards the extremity.

The ovigerous legs are inserted ventrally close to the lateral process of the first pair of legs. Of the first three joints, which are small, the third is the longest; the fourth is a great deal longer, and the fifth is the longest of all, in the males it has a strong knob near the extremity; the sixth joint is almost as long as the fourth. The four last joints show no great difference; from the seventh to the tenth they gradually diminish in length and in breadth. The claw is as long as the tenth joint, and on the inside is furnished with a row of small spines. The hairs on the joints of the ovigerous legs are not very strong. I have figured the denticulated spines in Pl. XI. fig. 5.

The legs are very long. The second joint is thrice as long as the first and as the third. In the female it is considerably swollen towards the extremity, where the genital opening is observed on the ventral surface. Of the three following joints the fourth and the fifth are nearly of the same length, while the sixth is almost once and a half as long. The first tarsal joint is extremely short, and the second about eight times as long. The claw is half as long as the second tarsal joint. The joints of the leg are furnished with extremely long and slender spines; two are placed at the distal extremity of the first joint, two in the middle of the second joint, and two others towards the extremity of that joint; a row of slightly shorter ones is observed on the dorsal surface towards the extremity of the third joint; the fourth, fifth, and sixth joints are also furnished with some of these hairs placed at irregular distances from one another; towards the extremity of these joints a certain number of these hairs is invariably observed. The first tarsal joint (fig. 6) shows only a few very short spines, whereas the second tarsal joint towards the side opposite to the claw is furnished with a complete row of very stout spines. Most of these spines, like the greater part of those placed on the other joints, are not quite smooth, but are furnished on one side with sharp short triangular hooks not unlike the teeth of a saw.

Of the three specimens of this species, one is a female, and two are males. I believe they are all full-grown animals. One of the males shows the remains of egg-packets adhering to the ovigerous legs. The genital openings of the females are much larger than those of the males. Both sexes have them placed ventrally on the second joint of all the legs.

Habitat.—This beautiful species was dredged in the neighbourhood of Melbourne.

Station 162. April 2, 1874. Off East Moncoeur Island, Bass Strait. Depth of the sea, 38 to 40 fathoms. Bottom of the sea, sand.

Also between Melbourne and Sidney at Station 163. April 4, 1874. Lat. 36° 56′ S., long. 150° 30′ E. Trawled in 120 fathoms. Off Twofold Bay.

Observations.—Perhaps this species is nearly allied to *Pallene chiragra*, Milne-Edwards, Histoire naturelle des Crustacés, tom. iii. p. 535. He gives the following description of this species :—" Corps très-grêle ; tête courte mais cylindrique. Second article

des pates-mâchoires très-renflé, et premier article du thorax extrêmement allongé. Pates environ cinq fois aussi longues que le corps, sans crochets accessoires au bout. Pates accessoires de la femelle de dix articles." However, as in this description the very distinct spines on the legs have not been mentioned, which, if present, would certainly have been seen by Milne-Edwards, I think it probable that his *Pallene chiragra* is a nearly allied but distinct species. Jarvis Bay, New Holland, where Milne-Edwards's species was collected, is not far from Station 163.

Pallene lævis, n. sp. (Pl. XI. figs. 8–12).

Diagnosis.—Body robust, lateral processes scarcely separated. Body and legs smooth. Proboscis short, conical; inserted about the front of the cephalothoracic segment. Ovigerous legs with denticulate spines and a long claw. Legs without auxiliary claws.

Description.—

Length of the proboscis, ...	1 mm.
Length of the trunk, ...	2·66 ,,
Length of the abdomen, ...	5·0 ,,
Total length of the body, ...	4 ,,
Length of the ovigerous leg, ...	6 ,,
Length of the leg of the third pair, ...	21·5 ,,

The body of this species is robust. The cephalothoracic segment is of a curious shape: it is considerably swollen at the front, where it bears the proboscis and the mandibles; it is constricted in the middle, thus forming a sort of short neck, and it is much wider again at the back, where it bears dorsally the oculiferous tubercle, and ventrally the short lateral processes for the insertion of the ovigerous legs. The oculiferous tubercle, with two larger eyes directed forwards and two smaller ones backwards, is situated almost exactly above the insertion of the ovigerous legs. The lateral processes for the insertion of the legs are comparatively long; the abdomen is short and stout.

The proboscis is short and conical, and has a very small mouth at the extremity. The mandibles are rather stout. The basal joint is constricted at the base, and indistinctly divided into two joints, it is nearly as long as the proboscis; the second joint is placed at right angles with the basal joint, and is considerably swollen and stout. At the extremity it is furnished with two claws, one straight, pointed and immovable, the other curved and movable, but also pointed. The inner surface of these claws is smooth, but there is a blunt point in the middle of the movable claw.

The ovigerous legs of the female specimen (the only one dredged) are not very strong. The first three joints are small, the fourth and the fifth are the longest, nearly of the same length and a little curved. The sixth joint is not quite half as long as the fifth. The four last joints are but little shorter than the sixth. This claw is compar-

atively strong: it is not denticulated on the inner surface but slightly serrated. The joints of the ovigerous legs are almost quite smooth. The shape of the denticulate spines is very curious. They are broad and flat, have two or three stronger teeth on each side near the base, and extremely fine teeth all over the rest.

The very smooth legs are comparatively long. The first and the third joints are short and almost of equal length, the second joint is more than twice as long, having a large oval genital opening at the extremity on the ventral surface. The fourth joint, containing the ovary, is considerably swollen and very long; the fifth is only a little shorter, the sixth, on the contrary, is a little longer. The two tarsal joints are very small, together about one-fifth of the length of the sixth joint. Almost every joint describes a feeble but characteristic curve; especially the second, the fourth and the eighth joint. The first tarsal joint is extremely small, and is furnished with a large number of hairs and an isolated stronger spine, the second tarsal joint also shows a number of hairs and four stronger spines opposite to the claw. The claw is strong and very long, considerably curved, and without auxiliary claws.

The only specimen of this species dredged during the cruise of H.M.S. Challenger is a female, which, I think, is a full-grown one.

Habitat.—This species, along with a specimen of *Pallene australiensis*, Hoek, was collected at Station 162. April 2, 1874. Off East Moncœur Island, Bass Strait. Depth of the sea, 38 to 40 fathoms. Bottom of the sea, sand.

Observations.—This very characteristic species may be easily recognised among the different species of *Pallene* by the form of the proboscis and cephalothoracic segment, by the shape of the denticulate spines of the ovigerous legs, by the presence of a claw at the end of the ovigerous leg, and finally by the absence of auxiliary claws at the end of the legs.

Pallene languida, n. sp. (Pl. XII. figs. 1–5).

Diagnosis.—Body highly concentrated, rather disciform. Proboscis conical, cephalothoracic segment comparatively long. Ovigerous legs with denticulated spines, but without a claw. Legs without auxiliary claws. Oculiferous tubercle conical, elevated. Rudiments of palpi in the form of knobs.

Description.—

Length of the proboscis, ...	0·45 mm.
Length of the trunk, ...	1·35 „
Total length of the body, ...	1·8 „
Length of the ovigerous leg, ...	2·3 „
Length of the leg of the third pair, ...	5·1 „

Of this curious species, unfortunately, only a single specimen was collected, and this specimen had, moreover, suffered much from the alcohol; it is visibly crumpled, especially

on the cephalothoracic segment, as seen from the dorsal side; the other segments have also suffered in a less degree, which makes it very difficult to judge of the original form.

The proboscis is small, obtusely conical; the mouth is small, as in the other species of this genus. The cephalothoracic segment is considerably swollen anteriorly, where it bears the proboscis and the mandibles; in the middle it is constricted so as to form a neck, and posteriorly it becomes wider again. This wider part (the thoracic part of the cephalothorax) bears the conical oculiferous tubercle, which shows only rudimentary eyes. The cephalothoracic segment seems, like the two following segments, to get considerably wider posteriorly on the dorsal surface, thus forming large folds in the breadth above the insertion of the first three pairs of legs. The fourth thoracic segment is quite flat; the lateral processes for the insertion of the legs are extremely short. The abdomen is very small but comparatively broad.

The surface of the body is smooth; on the mandibles, the ovigerous legs, and the legs, numerous not very long but spiny hairs are observed. The first joint of the mandibles reaches as far as the tip of the proboscis. The second joint is not very strong, is furnished with slender pincers, and is armed on the inner side with four short teeth. Rudiments of palpi are implanted ventrally near the base of the mandibles; they are only one-jointed knobs.

The ovigerous legs are short, little longer than the body. The first three joints are short; the two following joints are much longer; the fifth is the longest and is armed near the distal extremity with a small knob; the sixth joint is short. Of the four following joints the first is the longest, the last three are nearly of the same length. There is no claw at the end of the tenth joint. The denticulate spines of one and the same joint are by no means all of the same shape, those placed near the preceding joint are a great deal smaller than those in the middle of the row, whereas those placed at the end of the row are the largest of all, and are furnished at the base with three strong teeth of which the third especially is very large (fig. 5).

The length of the legs is almost three times the length of the body. The first three joints are small; the three following are much longer, but not very slender. The seventh joint is extremely short; the second tarsal joint is nearly six times as long. Besides the hairy spines on all the joints, which, as far as I could ascertain, are scattered rather irregularly over the surface, the last joint has, on the inner side, a row of short and comparatively strong spines. The claw at the end of the leg is long and stout. Auxiliary claws are wanting.

Of this species only a single specimen was obtained during the cruise of the Challenger, and, judging from the knobs at the end of the fifth joint of the ovigerous leg, I consider it to be a male.

Habitat.—*Pallene languida* was dredged at

Station 161. April 1, 1874. Off the entrance to Port Philip (Melbourne, Australia). Depth of the sea, 38 fathoms. Bottom of the sea, sand.

Observations.—This species is in all probability nearly allied to *Pallene longiceps*, Böhm (Sitzungsberichte der Gesellsch. Naturf. Freunde in Berlin, 1879, p. 59). However, as no figure of Böhm's species has ever been published, and as the description of it cannot be entirely applied to my specimen, I thought it safer to consider, and to describe this as a new species.

Pallene longiceps, Böhm, has rudimentary two-jointed palpi, and a short and blunt oculiferous tubercle. Moreover, the form of the denticulated spines of the ovigerous legs of the present species is different from the form described by Böhm for his *Pallene longiceps*. The latter species is from Japan, whereas my *Pallene languida* was obtained in the vicinity of Melbourne.

Phoxichilidium, Milne-Edwards.

Phoxichilidium fluminense, Kröyer (Pl. XIV. figs. 1–4).

Phoxichilidium fluminense, Kröyer, Bidrag til Kundskab, &c., Naturh. Tidskr. Ny Raekke, vol. i. p. 124, 1845, Tab. i. fig. 1*a–f*.

Pallene fluminensis, Kröyer (sp.), Böhm, Pycnogoniden des Museums zu Berlin, Monatsbericht der k. A. der Wissensch. zu Berlin, Februar 1879, p. 180, Taf. i. fig. 4–4*f*.

This species has been described and figured by Kröyer (*loc. cit.*), and again by Böhm (*loc. cit.*). It may not, however, be considered superfluous to publish new figures; those of Kröyer are in general highly characteristic, but they are, as regards the details, not very exact; from Böhm's figure, which has been drawn on much too small a scale, nobody, I think, would recognise the species.

The description given by both authors is nearly correct. The basal joint of the mandible reaches farther than the tip of the proboscis; it shows dorsally a little beyond the middle a slight angle, furnished with a row of stronger hairs: therefore the joint seen from the dorsal surface seems to be divided into two. Rudiments of palpi are present in the form of rounded knobs on both sides of the cephalic segment. The ovigerous legs of the full-grown animal are ten-jointed; I have figured joints six to ten in fig. 3. The sixth joint shows a wreath of short strong spines immediately before the articulation with the seventh joint. The seventh to the tenth joints are armed with curved spines and strong hairs, but no denticulate spines at all are present. These last five joints of the ovigerous leg are very curiously bent in the form of an S, as has been correctly observed and drawn by Kröyer. The legs are comparatively stout. The only specimen of this species brought home by the Challenger is a male, with rounded, rather large genital openings, which, as far as I could ascertain, are present only on the ventral surface of the second joint of the two hindermost legs. The fourth joint of the leg is more than twice as long as the second, and not inconsiderably swollen in the Challenger specimen; ventrally a little in front of the middle it is furnished with a distinct and comparatively strong tubular process, which in all probability communicates

with a gland situated in the interior of the joint. This tubular process has been observed neither by Kröyer nor by Böhm. Probably it occurs only in the male sex. The fifth joint is as long as the fourth, the sixth a little longer. The first tarsal joint is short, the second comparatively long, armed with a claw and two long auxiliary claws. Joints one to four have only a few hairs, while joints five to eight are covered by numerous, and for the most part, comparatively long and stout hairs.

Habitat.—This species, according to Kröyer, is found off Rio de Janeiro, whereas Böhm describes specimens collected by the German man-of-war, the "Gazelle," in the Straits of Magellan, and on the Patagonian coast, at a depth of 30 to 42 fathoms. One specimen was dredged by the Challenger off Bahia. Depth, from 7 to 20 fathoms.

Observations.—Böhm considers this species a *Pallene.* I think, however, there can be no doubt that it is a true *Phoxichilidium* in the sense of Kröyer. To take the number of joints of the ovigerous legs as a decisive proof in this matter is, I think, not safe. The ovigerous legs of the *Pallene* (*Pallene lappa,* Böhm) which Böhm examined, were only seven-jointed, and for that reason alone the specimen cannot be considered as a *Phoxichilidium.* Of much greater value, I think, is the form of the ovigerous leg itself, the form of the last joints, of the spines with which they are furnished, &c., also the whole form of the body, the manner in which the cephalic part of the cephalothoracic segment overhangs the proboscis, &c.

Another question is, of course, whether it would not be convenient to class as a separate genus those forms of *Phoxichilidium* which have ten-jointed ovigerous legs, probably always present in both sexes. But before taking this step, the different forms ought to be better known, and for this a close study of full-grown specimens of both sexes is necessary. The genus *Anoplodactylus* of E. B. Wilson cannot be accepted, because neither the presence or absence of auxiliary claws, nor the fact of the ovigerous legs being five- or six-jointed, has any real importance.

Phoxichilidium insigne, n. sp. (Pl. XIV. figs. 5–7).

Diagnosis.—Body slender, with large intervals between the lateral processes. Proboscis cylindrical, inserted ventrally far posteriorly between the two ovigerous legs. Mandibles two-jointed, the first joint bearing the second laterally. Ovigerous legs six-jointed. No auxiliary claws. Legs and mandibles furnished with large conical knobs.

Description.—

Length of the proboscis,	2 mm.
Total length of the body,	6 „
Length of the abdomen,	0·5 „
Length of the ovigerous leg,	4·2 „
Length of the leg of the first pair,	19 „

Of this most curious form, unfortunately, only a single specimen—and that much

mutilated, with only five legs—was collected during the voyage of the Challenger. This specimen is, I think, a full-grown male. The body is extremely slender, with very large intervals between the lateral processes for the insertion of the legs. The cephalothoracic segment is rather short, about twice as long as the first true thoracic segment; the second thoracic segment is a little longer than the first, and the third is, again, a little shorter. The proboscis is long, inserted ventrally, far back between the two ovigerous legs. It shows a little swelling at its base, in the middle, and again at the extremity. The mouth is small and triangular. The abdomen is short and directed somewhat upwards.

At the base of the mandibles the front part of the cephalothoracic segment is for a short distance cloven in the middle. Immediately behind this cleft the blunt oculiferous tubercle, with its four dark eyes, is placed. The basal joints of the mandibles diverge considerably, and extend beyond the front of the proboscis. The end of this basal joint, which is directed forwards, terminates in a pointed appendage, and laterally, underneath the end of this appendage, the short second joint is attached. This has the form of a bird's head with the small pincers as jaws. The inner surface of these pincers is smooth. The first joint towards its extremity and the whole surface of the second joint are covered with numerous long hairs.

The ovigerous legs are inserted close to the base of the proboscis; they are six-jointed; the first joint is small, the second about half as long as the proboscis, the third nearly as long as the proboscis, the fourth half as long as the second, the fifth a little shorter than the fourth, and the sixth extremely small. All the joints are furnished with numerous small hairs; those on the two last joints are a little longer, but still extremely slender.

The first joint of the legs is small, nearly as long as the lateral process, the second joint is more than twice as long as the first, the third joint nearly half as long as the second, the fourth is as long as the trunk with the abdomen, the fifth is but little shorter, the sixth is as long as the whole length of the body, the seventh is short, and the eighth nearly as long as the second joint. The part of the eighth joint facing the strong claw has a distinct shoulder, furnished with spines and small hairs. The first joint of the leg bears at the distal extremity, on both sides, a strong conical protuberance; the second bears a still larger one ventrally, and another at the distal extremity; the third, too, is furnished with one. Besides three strong protuberances at the distal extremity, the longest of which is placed between the two others, the fourth joint has three other protuberances placed laterally on the joint; one of these is placed in the middle, the two others on the other side at equal distances from the middle one. The protuberances at the extremity of the joint are much larger than the others found on the joint. The latter have, moreover, a slender spine at the top. The armature of the fifth joint is nearly the same as that of the fourth. The sixth joint is furnished with numerous small protuberances, bearing slender spines at the top. Distinct hairs are seen on all the joints; towards the fourth joint they grow stronger and denser. The side of the last

joint facing the claw when it is closed is furnished, in addition to numerous slender spines, with a row of curiously-shaped teeth (see fig. 7 of Pl. XIV.). The last joint terminates in a strong protuberance, like those placed at the extremities of the other joints of the leg. The claw is long and stout; auxiliary claws are wanting.

I think the only specimen of this species dredged by H.M.S. Challenger is a male. I could not, however, ascertain the sex without injuring the specimen, and I can only state my supposition. It is based on the fact that there are species of *Phoxichilidium* in which six-jointed ovigerous legs are present only in the male, and also on the presence of dermal glands in the fourth joint of the leg.

Habitat.—This curiously-shaped Pycnogonid was dredged off Bahia at a depth of 7 to 20 fathoms.

Observations.—I think this species of *Phoxichilidium* is a near relation of the European shore and shallow-water forms of the same genus (*Phoxichilidium femoratum*, *P. virescens*, &c.); from these it can be easily distinguished by the extremely characteristic protuberances on the legs, mandibles, &c.

Phoxichilidium patagonicum, n. sp. (Pl. XII. figs. 6–9).

Diagnosis.—Body robust, lateral processes scarcely separated. Basal joint of the mandibles indistinctly divided into two joints, second joint short, with small pincers. Palpi represented by large rounded knobs. Ovigerous legs ten-jointed, without claws, present in both sexes; auxiliary claws on the legs. Abdomen long.

Description.—Of this species a full-grown female and two small specimens, about whose sex I do not feel quite sure, were dredged by H.M.S. Challenger. For the description I have made use of the full-grown female.

Length of the proboscis, ...	6 mm.
Total length of the body, ...	16 „
Length of the abdomen, ...	5 „
Length of the ovigerous legs, ...	11 „
Length of the leg of the third pair, ...	57 „

The body of this species is almost entirely smooth; the cephalothoracic segment, which is not quite so long as the abdomen, bears the oculiferous tubercle quite at the front. The two following thoracic segments are together not quite so long as the cephalothoracic segment. The last segment is very small, it bears a long abdomen directed upwards. The length of the lateral processes is very considerable.

The proboscis is ventrally inserted, its base is found considerably behind the front margin of the cephalothoracic segment. It is comparatively long, and its shape is cylindrical; the extremity is rounded, with a small triangular mouth.

The mandibles are inserted close to each other and have a very long basal joint,

which, seen from the dorsal side about the middle, shows a distinct articulation. This basal joint is considerably swollen at the extremity; the second joint is directed towards the ventral side, while its pincers are bent laterally, so as to be directed towards those of the other mandible. These pincers are smooth and extremely short. While the basal joint of the mandibles is nearly smooth, the second joint is furnished with numerous and strong hairs, which are a little stronger still at the base of the pincers.

The palpi are represented by large rounded tubercles, placed at both sides of the base of the proboscis.

The ovigerous legs are comparatively short (at least in the female). The first joint is very small, the second is elongated and not quite three times as long as the first, the third is again short, the fourth and fifth joints are longer, the sixth is only two-thirds the length of the fifth, and the last four joints are small. They are figured on Plate XII. fig. 8, and are covered with long spiny hairs. There is no claw at the end of the tenth joint.

The first joint of the legs is small, the second is more than twice as long, and becomes considerably thicker towards the extremity, the third joint is only a little longer than the first, the three following are about the same length; the fifth joint, however, is the smallest, the sixth the longest. This joint in the second leg of the right side describes a slight curve, which at the convex side is surmounted by a strong conical protuberance. I think, however, there can be little doubt that this conical protuberance is to be considered as an accidental outgrowth caused probably by the joint having been broken and afterwards healed. The first tarsal joint is very short, and the second is about as long as the second joint of the leg. At its extremity the last joint bears a comparatively feeble claw and two auxiliary claws. The joints of the legs have numerous but small and stout hairs; they are at the swollen extremity of the second joint, and on the third and the fourth joints; on the following joints they are much more numerous, but also a great deal more slender. On the two last joints, which have also stronger spines, for example on the side facing the claw, they are most numerous of all.

The female specimen shows very large genital pores at the considerably swollen distal extremity of the second joint of the leg. They are found ventrally on all the legs. The specimens seem to be very brittle, especially the younger ones, which had lost nearly all their legs.

Habitat.—This species was collected at three different stations not far from the coast of Patagonia.

Station 304. December 31, 1875. Lat. 46° 53′ S., long. 75° 11′ W. Depth of the sea, 45 fathoms. Bottom of the sea, sand.

Station 308. January 5, 1876. Lat. 50° 10′ S., long. 74° 42′ W. Depth of the sea, 175 fathoms. Bottom of the sea, mud.

Station 313. January 20, 1876. Lat. 52° 20′ S., long. 68° 0 W. Depth of the sea, 55 fathoms. Temperature at the bottom, 8·8° C. Bottom of the sea, sand.

Observations.—In general, the shape of this *Pycnogonid* resembles that of *Phoxichilidium digitatum*, Böhm. However, in many respects, it may be easily distinguished from this and other species of *Phoxichilidium* hitherto described; for instance, by the presence of ovigerous legs in the female, by the presence of auxiliary claws, by the number of joints (10) of the ovigerous legs, &c. Like most other species of the same genus, this species seems only to occur in shallow water (depth 45 to 175 fathoms) not far from the coast.

Phoxichilidium patagonicum, var. *elegans*, n. var. (Pl. XII. fig. 10).

Diagnosis.—Like *Phoxichilidium patagonicum*, Hoek, only much more slender.

Description.—

Length of the proboscis, ...	3·5 mm.
Total length of the body, ...	9·5 „
Length of the abdomen, ...	2·5 „
Length of the leg of the third pair, ...	28·5 „
Length of the ovigerous leg, ...	4 „

A young specimen has the different thoracic segments by no means so concentrated or robust as is the case in the specimens of *Phoxichilidium patagonicum;* the lateral processes are much more widely separated; in general the length of the body, in comparison with that of the legs and of the proboscis, is much more considerable. The oculiferous tubercle is furnished with four eyes, but the two foremost are much larger than the two others. The length of their legs and their joints is not very different from that of *Phoxichilidium patagonicum;* the only difference being that the total length is comparatively less. The claws and the auxiliary claws are as in *Phoxichilidium patagonicum.* About the sex of this specimen I do not feel quite sure: most probably it is a young female.

Habitat.—Station 320. February 17, 1876. Lat. 37° 17′ S., long. 53° 52′ W. Depth of the sea, 600 fathoms. Bottom temperature, 2·7° C. Bottom of the sea, hard ground.

Observations.—The single specimen of this form resembles *Phoxichilidium patagonicum* so strongly that I hesitated long whether or not I should consider it as specifically distinct. My study of other species, younger and older specimens, has convinced me that, as a rule, as the animal advances in age, its slenderness increases. Now, in the present case, a young specimen shows considerable slenderness, while the full-grown female is much more concentrated. That it is a young specimen is proved by the rudimentary condition of the ovigerous leg. I therefore feel inclined to consider this form as a variety of my *Phoxichilidium patagonicum.* Considering the difference in depth of the stations at which that species and the present form were dredged, we have here most probably an instance of the influence of surrounding circumstances on the form of an animal.

Phoxichilidium mollissimum, n. sp. (Pl. XIII. figs. 6–9).

Diagnosis.—Body robust, lateral processes not very widely separated. Mandibles distinctly three-jointed, with curved, smooth, and not very long pincers. Ovigerous legs ten-jointed, without claw (probably present in both sexes). Auxiliary claws (?). Palpi represented by small rounded protuberances. Legs with silky hairs.

Description.—

Length of the proboscis,	9·5	mm.
Total length of the body,	28	„
Length of the abdomen,	9	„
Length of the ovigerous leg,	20	„
Length of the first six joints of the leg,	110	„

Of this interesting deep-sea Pycnogonid, unfortunately only a single specimen (much injured) was collected during the voyage of H.M.S. Challenger. There is not a single complete leg; and of the incomplete ones, with their three joints, there are in all only three present. However, this form is so highly characteristic that I think it possible to give, even from this defective specimen, a description which will be recognised by future investigators.

The body is robust; like the proboscis, the lateral processes, and the first joints of the legs, it is entirely smooth. The front of the cephalothoracic segment projects over the base of the proboscis. This front part bears dorsally the blunt oculiferous tubercle, with its rudimentary eyes, and quite anteriorly the large mandibles are inserted. These run parallel to one another, and are distinctly three-jointed. The basal joint is comparatively long, swollen at its base, and again at the extremity; the second is about two-thirds the length of the basal joint; the third joint is very short, and terminates in a pair of smooth, strongly-curved pincers, which, when closed, have a wide interval between them.

The proboscis is very stout, swollen a little in the middle, and also at the extremity; seen laterally, the swelling at the extremity appears rather stronger on the dorsal than on the ventral side. The triangular mouth is quite closed by the labial plates. Near the base of the proboscis the cephalothoracic segment bears on both sides a small blunt protuberance, which represents the palpus.

The ovigerous legs are inserted ventrally. Seen from that side, the cephalothoracic segment is distinctly divided into two segments, and the ovigerous legs originate from the first of these two segments. They are inserted on small processes, which represent the lateral processes of the ovigerous legs, and have ten joints. The first and third joints are short; the second is about twice as long; the fourth is comparatively stout and longer than the second; the fifth is as long as the second, and much more slender than the fourth; the sixth is shorter than the fifth, slender, but swollen at the extremity. The last four joints do not show any great differences in length; however, from the

sixth to the tenth each joint is more slender than the preceding one. The hairiness of the different joints of the leg is not very great. Some hairs are found on the second to the sixth joints, the latter being, especially at the swollen extremity, furnished with some stronger hairs. The seventh joint is, near the extremity, armed with very long hairs; the eighth joint has them all over the surface; on the ninth joint the hairs are short and few; while the very slender tenth joint is furnished not only with some short hairs, but also with rows of stronger spines.

The lateral processes for the insertion of the legs are comparatively long. The abdomen is very long, being nearly cylindrical, and at the extremity a little swollen.

The second joint of the leg is twice as long as the first and the third. Of the three following joints, which are comparatively long, the first is a little longer than the second, and a little shorter than the third. With the exception of a row of not very numerous hairs placed at their extremities, the first three joints are smooth; the fourth shows already a small number of very thin hairs, which are much more numerous on the fifth, and extremely numerous on the sixth joints. On these last two joints, however, the hairs cover only half the surface longitudinally, whereas the other half has slender spines placed in distinct rows (fig. 9).

The single specimen of this species shows ventrally small genital pores on the second joint of the first, second, and third legs (the only legs present). From the smallness of these genital pores, the absence of ovaries in the fourth joint of the leg, and the shape of the ovigerous legs, I conclude that this specimen is a male.

Habitat.—The single specimen was brought up from

Station 237. June 17, 1875. Lat. 34° 37′ N., long. 140° 32′ E. Depth of the sea, 1875 fathoms. Bottom temperature, 1·7° C. Bottom of the sea, mud.

Observations.—This species and the two following (*Phoxichilidium oscitans*, Hoek, and *Phoxichilidium pilosum*, Hoek) are nearly allied. They are furnished with ten-jointed ovigerous legs, present in both sexes, and three-jointed mandibles. The late Dr R. von Willemoes-Suhm erroneously mentioned these species as belonging to the genus *Zetes*, Kröyer. When comparing these species with true three-jointed mandibles, with *Phoxichilidium fluminense*, Kröyer, with two-jointed mandibles, and a distinct row of spines dorsally near the middle, and with *Phoxichilidium patagonicum*, Hoek, which has the basal joint divided into two when seen from the dorsal surface, and quite undivided when seen from the ventral surface, it becomes evident that this division, even when so distinctly developed as is the case with *Phoxichilidium mollissimum*, *Phoxichilidium oscitans*, and *Phoxichilidium pilosum*, does not justify us in considering these species as belonging to a different genus. Even should this be proposed, they could never be considered as species of *Zetes;* for that genus has ten-jointed palpi, whereas these organs in the present forms have become entirely rudimentary.

Phoxichilidium oscitans, n. sp. (Pl. XIII. figs. 1–5).

Diagnosis.—Body robust, lateral processes not very widely separated. Mandibles three-jointed, with long and slender pincers. Ovigerous legs ten-jointed, without claws, probably present in both sexes. Auxiliary claws present. Palpi represented by rounded protuberances. Proboscis swollen in the middle, and considerably at the tip.

Description.—

Length of the proboscis,	8	mm.
Total length of the body,	21·5	„
Length of the abdomen,	6·5	„
Length of the ovigerous leg,	9·6	„
Length of the leg of the third pair,	97	„

A single specimen of this beautiful species was brought home by the Challenger. It is a species with a robust body, with long lateral processes, which are not widely separated, a very long abdomen, and a very stout proboscis. The first or cephalic part of the cephalothoracic segment is almost globular, and bears about its middle a blunt oculiferous tubercle with two rudimentary eyes, represented by brown spots, which are connected by a slender strip of pigment, the whole not unlike the form of what the French call a *pince-nez.* The cephalothoracic segment is nearly as long as the three other segments together. The abdomen is long, cylindrical, swollen at the extremity.

The proboscis is very stout; it is considerably swollen in the middle, and also at the extremity. This extremity is flattened at the front, and has a very large triangular mouth, the three lips of which are turned inwards. While the body is almost everywhere smooth, the front of the proboscis bears round the mouth not very long but comparatively strong hairs.

The mandibles are distinctly three-jointed. The first joint is the longest; the second is but little shorter; together they reach considerably beyond the end of the proboscis. The third joint is small, and bears a pair of extremely slender pincers, the movable one being much more strongly curved than the immovable one. At the end of the first joint a row of not very long but comparatively strong hairs is observed; those at the extremity and over the whole surface of the third joint are a little longer. The pincers are quite smooth.

The palpi are represented by very large globular protuberances, placed at both sides, near the base of the proboscis.

The ovigerous legs are inserted ventrally not far from each other. Seen from the ventral side, the cephalothoracic segment is much shorter than when observed dorsally; nor is there from that side any trace of a division into two joints to be seen, as is the case in *Phoxichilidium mollissimum*, Hoek.

The length of the joints of the ovigerous legs is exactly as in *Phoxichilidium*

mollissimum; the first and third joints are short, the second is a little longer, the fourth longest of all and much thicker; the fifth joint is only a little shorter than the fourth, but considerably more slender; the sixth again is a little shorter than the fifth, and swollen at the distal extremity. The last four joints are short and nearly of equal length. The hairs on these last joints are not so long, but more regularly spread over the surface, than is the case in *Phoxichilidium mollissimum.* The tenth joint, however, shows nearly the same row of spines and the same short hairs as in the foregoing species.

The legs are very long. The relative length of the joints is the same as in *Phoxichilidium mollissimum.* The seventh joint is short; the eighth joint is a little curved. Both these joints are slender; together they are nearly equal in length to the second joint of the leg. The claw is very long, and furnished with two small auxiliary claws. That side of the eighth joint which faces the claw shows a row of stronger spines, the last of which is considerably longer than the others. Besides distinct rows of stouter hairs at the extremity of the joints, the number of hairs on the surface of the joints considerably increases from the fourth joint downwards, the greatest number being found on the distal part of the sixth joint.

The only specimen is probably a male. Its genital openings are small, and are placed ventrally on the second joint of every leg.

Habitat.—This beautiful deep-sea species was found at

Station 70. June 26, 1873. Lat. 38° 25′ N., long. 35° 80′ W. Depth of the sea, 1675 fathoms. Sea bottom, globigerina ooze.

Observations.—This species is nearly allied to the foregoing (*Phoxichilidium mollissimum*, Hoek), and also to the following species (*Phoxichilidium pilosum*, Hoek). It may, however, be easily distinguished from these species by the form of the proboscis and of the cephalothoracic segment, and by its extremely long legs.

Phoxichilidium pilosum, n. sp. (Pl. XIII. fig. 10–13).

Diagnosis.—Body not very robust, lateral processes widely separated. Mandibles distinctly three-jointed, with small straight pincers. Ovigerous legs ten-jointed, without claws, present in both sexes. Auxiliary claws present. Palpi represented by rounded protuberances. Proboscis cylindrical, tapering towards the extremity. Body (dorsally) and legs covered with extremely long and thin hairs.

Description.—

Length of the proboscis,	5	mm.
Length of the abdomen,	5	„
Total length of the body,	15	„
Length of the ovigerous leg,	8	„
Length of the leg of the third pair,	44	„

Of this species three specimens were collected during the cruise of H.M.S. Challenger;

there are two females and a male. The male is a great deal smaller than the larger of the two females. I therefore give the description from the larger female. The body is stout, but, as the lateral processes are widely separated, not very robust. The cephalothoracic segment is not very long. Quite in front of it the oculiferous tubercle is inserted so as to overhang the base of the mandibles. It is much elevated, conical, with two larger eyes directed forwards, and two smaller ones directed backwards. The first and second true thoracic segments together are shorter than the cephalothoracic segment. The last thoracic segment is short, and bears at the extremity a very large abdomen, the length of which is nearly equal to that of the proboscis. The abdomen is a little swollen at the tip. Dorsally the surface of the body of the lateral processes and of the abdomen is furnished with very slender hairs, of which a distinct row is observed on the hinder margin of the different thoracic segments.

The two mandibles are three-jointed; the first two joints run parallel to each other. The first joint reaches as far as the end of the proboscis; the second joint is a little longer; the third is inserted on the second, with which it makes a right angle. The pincers of the two mandibles are directed horizontally towards each other; they are placed at a short distance from the end of the proboscis, are straight, and very short.

The proboscis is cylindrical, tapering towards the extremity, where the small mouth is situated. At the base of the proboscis the two protuberances representing the palpi are inserted.

The ovigerous legs are ten-jointed: the first and third joints are very small; the second is about twice as long; the fourth and fifth are the longest of all; the sixth joint is short; and of the four last joints the second is the longest and the last the shortest. They are covered with not very long but thin hairs, rows of stronger ones, as a rule, being found at the extremity of the joints.

The second joint of the legs is nearly twice as long as the first or third, and in the female considerably swollen at the extremity. The fourth joint is also considerably swollen in the female, and is longer than the first three joints together. The fifth joint is much more slender and also a little shorter than the fourth; the sixth is much longer and, at the same time, a great deal more slender. The two last joints together are not quite one-third the length of the sixth joint. The first tarsal joint is extremely short, the second about five times as long. From the first to the sixth all the joints are covered with very long and slender hairs, giving an extremely woolly appearance to the whole animal. The first tarsal joint is furnished with numerous stronger and smaller hairs; the second shows a row of distinct spines, the last of which is the largest, while the others diminish in size. The claw at the end of the leg is very large; it is accompanied by two extremely small auxiliary claws.

The females have very large genital openings ventrally on the swollen extremity of the second joint of all the legs. In the males I could observe the small genital pores only

on the ventral surface of the two hindermost legs. They are here placed at the tip of a small tubercle, which is likewise absent on the two first pairs of legs. The genital pores of the males are almost quite covered by the surrounding hairs.

This hairy Pycnogonid was dredged by the Challenger at two different stations.

Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E. Depth of the sea, 1600 fathoms. Temperature of the bottom, 0·8° C. Bottom of the sea, globigerina ooze.

Station 157. March 3, 1874. Lat. 53° 55′ S., long. 108° 35′ E. Depth of the sea, 1950 fathoms. Bottom of the sea, diatom ooze.

Observations.—The near relation which this beautiful deep-sea species bears to the two foregoing ones is evident. They form the true deep-sea representatives of the genus *Phoxichilidium*, Milne-Edwards, which probably will be found to have an extremely wide range.

Hannonia, n. gen.

Diagnosis.—Proboscis stout, inserted quite in front of the cephalothoracic segment. Mandibles rudimentary, small, two-jointed, chelate. Palpi wanting. Ovigerous legs, present in both sexes, ten-jointed.

Hannonia typica, n. sp. (Pl. XIV. fig. 8–11).

Diagnosis.—Body robust, proboscis long-ovate, truncated at the tip, and forming a narrow stalk posteriorly. Legs short, with a small first tarsal joint and a claw, without auxiliary claws.

Description.—

Length of the proboscis, ...	4 mm.
Length of the trunk with the abdomen, ...	7 „
Total length of the body, ...	11 „
Length of the leg of the third pair, ...	12 „

This curious sea-spider has a robust body; the cephalothoracic segment is not very large, and, like the two following segments, its hinder margin is furnished with an elevated ridge; on these ridges a row of small hairs is inserted. The oculiferous tubercle is blunt, and placed in the middle of the cephalothoracic segment. It is furnished with four comparatively large black-coloured eyes. The dorsal surface of the lateral processes, like that of the last thoracic segment immediately in front of the insertion of the abdomen, shows rounded protuberances, on the surface of which small hairs—like those of the ridges on the hinder side of the thoracic segments—are placed. The abdomen is not very long, but stout and swollen at its extremity. Its surface is likewise covered with numerous small hairs. The form of the proboscis is ovate; at the anterior end it is flattened and truncated. The mouth is found in the middle of this truncated surface; it is triangular, with comparatively large lips. At the back the proboscis is

narrower, the narrow part thus forming a sort of stalk-like process on which the ovate front part is borne. The surface of the proboscis, when seen with the naked eye or slightly magnified, is entirely smooth.

The mandibles are small and rudimentary; they consist of a short basal joint and a quite rudimentary second joint, armed with rudimentary pincers. The length of the mandibles is about one-fourth the length of the proboscis.

The ovigerous legs are not very strong; they are ten-jointed. The first three joints are short; the fourth and the fifth joints are the longest; the sixth is about two-thirds the length of the fifth; and of the last four joints the first is by far the longest, and the third the shortest. A small claw is found at the extremity of the tenth joint. All the joints are furnished with small hairs; the last four joints are not armed with denticulate spines, but with not very strong straight spines, scattered rather irregularly over the whole surface of the joints.

The legs are short. The first three joints are extremely short; the three following are longer and nearly of the same length, which is shorter than that of the first three joints together. The first tarsal joint is very short; the second comparatively long and feebly curved, it bears at the extremity a small strongly-curved claw, which is sickle-shaped, and not accompanied by auxiliary claws. All the joints of the legs are furnished with numerous minute spines, placed in regular rows; the fifth and sixth joints, however, are also armed with a distinct row of tubercles, each bearing a small but strong spine at the tip (fig. 11).

The only specimen of this species is a female. It has very large genital pores on the second joints of all the legs. The ovaries are found reaching as far as the sixth joint of the leg. The ovarian eggs are exceedingly numerous, but comparatively large.

This interesting Pycnogonid was found on the shore at Seapoint, near Capetown.

Observations.—It is a true shore inhabitant, and forms among the species without palpi the transition from those with (*Pallene* and *Phoxichilidium*) to those without mandibles (*Pycnogonum* and *Phoxichilus*). To the first of the latter genera (*Pycnogonum*) it is, I believe, very nearly allied—viz., by the robustness of the body and by the presence of the protuberances (which I showed in my paper published in 1877, Ueber Pycnogoniden, to be outgrowths of the skin, richly armed with tactile organs) on the dorsal surface of the body and of the lateral processes. The want of auxiliary claws in both genera is also striking. Distinct differences are furnished by the presence of mandibles, and of ovigerous legs in the female of my *Hannonia typica;* I have already pointed out above, however, that I do not consider these differeuces very important.

APPENDIX I.

DESCRIPTION OF THE SPECIES DREDGED DURING THE CRUISE OF THE "KNIGHT ERRANT."

During the recent cruise of the "Knight Errant," organised by Prof. Sir Wyville Thomson to acquire a more accurate knowledge of the abnormal distribution of temperature in the Faroe Channel, numerous Pycnogonids were collected by trawling. As this cruise bears upon the voyage of the Challenger and the study of the results of her voyage, I was asked to give also a description of these forms for this report.

Nymphon strömii, Kröyer.

Nymphon strömii, Kröyer, Bidrag til Kundskab, &c., Natürh. Tidskr., N. R., i. 111, 1845.
Nymphon gracilipes, Heller, Crustaceen, Pycnogoniden, und Tunicaten der K. K. Oester. Ungar. Nordpol. Exped. Denkschr. der Math., Naturw. Classe der Kaiserlichen Akad. der Wiss., xxxv. 40, 1875.
Nymphon strömii, Kröyer, Miers, Ann and Magazine, 4th series, vol. xx. p. 109, 1877.
Nymphon gracilipes, Heller, G. O. Sars, Prodromus descriptionis Crustaceorum et Pycnogonidarum, quae in expeditione Norvegica, anno 1876, observavit, Arch. f. Math. og Naturvid., ii. 265, 1877.
Nymphon strömii, Kröyer, Wilson, Pycnogonida of New England, Transact. Connect. Acad., vol. v. p. 17, pl. vi. fig. 1*a*–1*h*, 1880.

This beautiful and distinct species is accurately described by Kröyer, and also by Wilson. Its synonymy and wide geographical range I have discussed at some length in the description of the Pycnogonids collected during the two cruises of the Dutch schooner "Willem Barents" in the Barents Sea, which at this moment is in the hands of the printer, and will be published probably before the end of the year (1880).[1]

The dimensions of the "Knight Errant" specimens are much smaller than those of the specimens described by Heller and myself, and even smaller than those which Wilson has got from the neighbourhood of the North American coast.

The extent[2] of the largest "Knight Errant" specimen is not quite 100 mm. The

[1] Supplement-Band of the Niederländisches Archiv für Zoologie, Leiden, E. J. Brill.
[2] "Extent is the distance from tip to tip of the outstretched legs" (Wilson, *loc. cit.*, p. 5).

depth from which this species was brought up is from 515 to 540 fathoms. The stations where it was found are the following :—

Station No. 5 (cruise of the "Knight Errant"). Lat. 59° 26′ N., long. 7° 19′ W. August 11, 1880. 515 fathoms. Warm area. Two specimens.

Station No. 7 (cruise of the "Knight Errant"). Lat. 59° 36′ N., long. 7° 18′ W. August 12, 1880. 530 fathoms. Warm area. Two specimens.

Station No. 8 (cruise of the "Knight Errant"). Lat. 60° 3′ N., long. 5° 51′ W. August 17, 1880. 540 fathoms. Cold area. Ten specimens.

In this animal, therefore, we have an example of one inhabiting the cold and warm areas on both sides of the ridge rising in the Faroe Channel to within 300 fathoms of the surface.[1] This agrees very well with the facts of the geographical distribution of our species; it is a common inhabitant of the depths of the Arctic Sea, but it is also by no means rare in the deeper water of southern latitudes, especially in the neighbourhood of the American coast.

Nymphon grossipes, Oth. Fabricius.

Nymphon grossipes, O. Fabricius, Fauna Groenlandica, p. 229, 1780. (See p. 44 of this report.)

A single specimen of this species was dredged at

Station 8 (cruise of the "Knight Errant"). Lat. 60° 3′ N., long. 5° 51′ W. August 17, 1880. 540 fathoms. Cold area.

For the geographical distribution of this species I refer to the list of species at p. 20.

Nymphon macronyx, G. O. Sars (Pl. XV. figs. 1–7).

Nymphon macronyx, G. O. Sars. Prodromus descriptionis, &c., Archiv. f. Math. og Naturvid., ii. 265, 1877.

Of this interesting inhabitant of the cold area of the Faroe Channel about thirty specimens were dredged during the cruise of the "Knight Errant." As hitherto neither a full description nor any figure of this species has been published, I wish to give both here.

Only a short diagnosis of this species has been published by Professor G. O. Sars. From this, and from the pencil drawing he had the kindness to send me, the species is easily recognised. However, in some respects, I observed slight differences from the diagnosis of Professor G. O. Sars. Probably these will be found to arise from the fact that the species had been submitted only to a preliminary investigation by the celebrated Norwegian zoologist.

Nymphon macronyx, G. O. Sars, is a somewhat robust *Nymphon*, having the second joint of the palpi longer than the third, the first tarsal joint not quite half the length of the second tarsal joint, and having a very long claw at the end of every leg and

[1] Nature, September 2, 1880, C. Wyville Thomson, the Cruise of the "Knight Errant."

extremely small auxiliary claws. Moreover, it is characterised by a curiously-shaped oculiferous tubercle. Its dimensions are as follows :—

Length of the proboscis,	2·3 mm.
Total length of the body, ♀,	5·4 ,,
Total length of the body, ♂,	5·7 ,,
Length of the ovigerous leg, ♀,	6·4 ,,
Length of the ovigerous leg, ♂,	7·1 ,,
Length of the leg of the third pair,	18 ,,

The body is almost quite smooth, while the appendages are richly furnished with hairs. The slenderness of the body is not very great; the lateral processes, however, are widely separated (Pl. XV. fig. 1). The cephalothoracic segment is shorter than the proboscis; it is narrow in the middle, while it shows a considerable swelling at the beginning and at the end. The oculiferous tubercle is situated above the insertion of the ovigerous legs. Seen laterally this shows the conical and pointed shape described by Professor G. O. Sars; but seen from the front it is considerably flattened and broad, terminating in two divergent points. It is furnished with four distinct eyes (Pl. XV. fig. 2). The proboscis is almost quite cylindrical. The abdomen is short.

Of the appendages I have figured the mandibles in fig. 3 on Plate XV. The second joint is nearly triangular, and almost its whole surface is covered by strong hairs. At the front one of the angles of the triangle terminates in the immovable claw, which is a great deal shorter than the movable one. Both claws bear a row of spines, and are strongly curved at their extremities.

The drawing I have given in fig. 4 of the palpi renders, I believe, a description needless.

The ovigerous leg of the female is shorter and feebler than that of the male; moreover, it has the fourth and fifth joints quite straight, whereas the same joints in the male describe distinct curves. The relative length of the joints is the same as in most other species of the genus *Nymphon*. In the male the sixth joint is furnished with a small pointed tubercle, which I did not observe in the female. The males bear the eggs on the fourth and fifth joints; they are large and collected in one or two packets on both legs. The four last joints show a row of denticulated spines of the shape figured on Plate XV. fig. 5. The claw at the end of the ovigerous leg is strong and pectinated at the extremity.

The second joint of the legs is twice as long as the first and the third, the fourth joint is as long as the fifth, the sixth is only a little longer. The first tarsal joint is not quite half as long as the second. The claw is very long, almost as long as the second tarsal joint. Very small auxiliary claws, easily overlooked, are situated on both sides of the great claw (fig. 7). The second joint of the female is considerably swollen at the end, where it shows on every leg a large genital pore of an oval shape; the fourth joint in the same sex is also swollen. The hairs on the first four joints in both sexes are not very numerous, whereas, beginning with the fifth, the last joints are richly furnished

with hairs. The side of the eighth joint facing the claw shows a row of regular strong spines. The genital pores of the males are smaller than those of the females; they are present only on the two posterior pairs of legs.

As for the geographical distribution of this species, G. O. Sars dredged it in lat. 62° 44′ 5″ N., long. 1° 48′ E., in comparatively deep water (412 fathoms), in the cold area. He found there only four specimens, whereas a single haul with the trawl in the Faroe Channel yielded among a thousand specimens of *Nymphon robustum*, Bell, upwards of thirty specimens of the species in question. This occurred at

Station No. 8 (cruise of the "Knight Errant"). Lat. 60° 3′ N., long. 5° 51′ W. August 17, 1880. 540 fathoms. Cold area.

This station is not very far from the place where it was dredged by Professor G. O. Sars, and as this is the only instance, so far as I know, of this species having been collected previous to the cruise of the "Knight Errant," most probably it has a very restricted distribution.

Nymphon robustum, Bell.

Nymphon robustum, Bell, Belcher's Last of the Arctic Voyages, vol. ii. p. 409, 1855, Tab. xxxv. fig. 4.
Nymphon abyssorum, Norman, Wyville Thomson, Depths of the Sea, p. 129, 1873.
Nymphon hians, Heller, Crustaceen, Pycnogoniden und Tunicaten der K. K. Oester. Ungar. Nordpol. Exped. Denkschriften der Wiener Akademie der Wiss., xxxv. 41, 1875.
Nymphon robustum, Bell, G. O. Sars, Prodromus Crustaceorum et Pycnogonidarum, Arch. für Math., og Naturvid., ii. 265, 1877.

An ample discussion of the synonymy of this species, and a description of those parts of the body which have hitherto been overlooked, I have given in my paper on the Pycnogonids of the cruises of the "Willem Barents," to which I have referred above. An immense quantity of this true cold area species was dredged during the recent cruise of the "Knight Errant." Mr Murray writes to me that this was the greatest haul of Pycnogonids he ever observed. It is a blind species, and along with it were trawled a considerable number of specimens of *Nymphon macronyx* which have distinct eyes, about ten specimens of *Nymphon strömii* also furnished with eyes, one specimen of *Nymphon grossipes* with eyes, and four specimens of *Colossendeis proboscidea*, Sabine (sp.), which is again without eyes. The number of specimens with eggs is not very considerable, and there is not one which shows the numerous highly developed young ones clinging to the ventral side of the body of their parent as is the case with some specimens from Barents Sea.

Finally, I wish to point out that the dimensions of the "Knight Errant" specimens are considerably smaller than those of specimens from higher latitudes. As I have mentioned above, this is also the case with the specimens of *Nymphon strömii*.

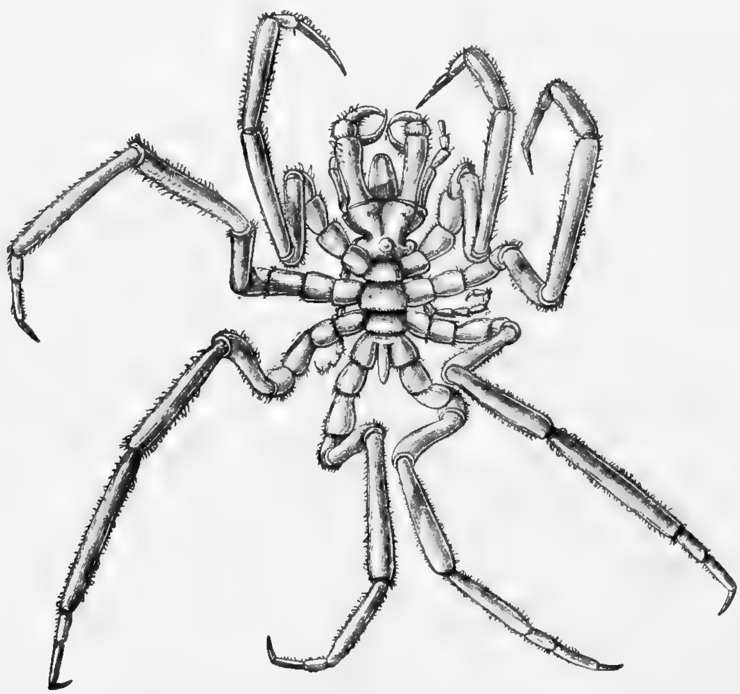
A species of *Scalpellum*, which, so far as I know, has not been observed hitherto, is a common commensal on the legs of *Nymphon robustum*, Bell.

This species was dredged at

Station 8 (cruise of the "Knight Errant"). Lat. 60° 3′ N., long. 5° 51′ W. August 17, 1880. Depth of the sea, 540 fathoms. Cold area. Perhaps 1000 specimens.

Station 2 (cruise of the "Knight Errant"). Lat. 60° 29′ N., long., 8° 19′ W. July 28, 1880. Depth of the sea, 375 fathoms. Warm area. One specimen only.

This single specimen from the warm area must, most probably, be considered as one which has strayed from the cold area. As far as I know, the species has not been observed at a lower latitude than 60° N.



Nymphon robustum, Bell.

Colossendeis proboscidea, Sabine (sp.).

Phoxichilus proboscideus, Sabine, Marine Invertebrate Animals in a Supplement to the Appendix of Captain Parry's Voyage for the Discovery of a North-West Passage in the years 1819–1820, London, John Murray, 1824, p. ccxxvi.

Colossendeis borealis, Jarzynsky, Præmissus Catalogus Pycnogonidarum inventarum in mari glaciali ad oras Lapponiæ rossicæ et in mari albo, anno 1869 et 1870. Annales de la Soc. des Naturalistes de St Pétersbourg, vol. i., 1870.

Colossendeis proboscidea, Sabine (sp.), G. O. Sars, Prodromus descriptionis, &c., Archiv. für Math. og Naturvid., ii. 268, 1877.

Of this interesting species, the first of the genus *Colossendeis* that was observed, four specimens were trawled at Station 8, together with many specimens of *Nymphon*

robustum, *Nymphon macronyx*, &c. (See above.) There is one very young specimen, and the three others are females. For figures and a full description of this species I again refer to my paper on the Pycnogonids of Barents Sea.[1]

The specimens trawled by the "Knight Errant" are not quite so large as those from Barents Sea.

Station 8 (cruise of the "Knight Errant"). Lat. 60° 3′ N., long. 5° 51′ W. August 17, 1880. Depth of the sea, 540 fathoms. Cold area.

Pycnogonum litorale, Ström (sp.).

Phalangium litorale, Ström, Physisk og oeconomisk beskrivelse over fogderiet Söndmör, beliggende in Bergens Stift i Norge, 4°. Soröe, 1762-66, pl. i. fig. 17.
Pycnogonum litorale, O. Fabr., Fauna Groenlandica, p. 223, 1780.
Pycnogonum litorale, Müller, Zoologia Danica, iii. 68, pl. cxix. figs. 10–12, 1789.
Pycnogonum litorale, Kröyer, Nat. Tidsk. Ny Række, i. p. 126, 1845.

Of this very common species one specimen was dredged at 53 fathoms. It occurs only in the neighbourhood of the coast, and ranges to the north as far as the White Sea, where Jarzynsky (Præmissus Catalogus, &c., *loc. cit.*) collected it on the coast of Russian Lapland, and as far south as the coast of the Mediterranean. Westward it is common at different places on the North-American coast, and it also abounds on the east coast of the Atlantic—as on the English, Dutch, French coasts, &c. Slater (Ann. and Mag. of Nat. Hist., v. series, vol. iii., 1879) describes a variety of this species—it is a little more slender—collected on the coast of Japan. Most probably, therefore, the species will also be found to occur along the whole northern coast of Siberia.

The single specimen trawled in the neighbourhood of the Scottish coast is a male with distinct ovigerous legs. It was dredged at

Station No. 3 (cruise of the "Knight Errant"). Lat. 59° 12′ N., long., 5° 51′ W. August 3, 1880. Depth of the sea, 53 fathoms.

[1] This same species has been recently described by Mr E. J. Miers under the name *Anomorhynchus smithii*, n. gen., n. sp., from specimens collected by Mr Leigh Smith a little to the south of Franz-Josef Land (Annals and Magazine of Natural History for January 1881, p. 50, pl. vii. figs. 6–8). (Note inserted during the correction of the last proof.)

APPENDIX II.

CONTRIBUTIONS TO THE ANATOMY AND EMBRYOLOGY OF THE PYCNOGONIDA.

Our knowledge of the anatomy and embryology of the sea-spiders is very insufficient; of those living in shallow water we know but little, and of the deep-sea forms nothing. Whereas *a priori* it is evident, that in general the deep-sea animals will exhibit the same anatomical structure, and pass through the same development as the littoral or shallow-water forms; it is also clear, on the other hand, that a comparison of the anatomy of animals inhabiting very different depths might lead, at least in the case of some organs, to very interesting results.

As the rich material collected during the voyage of H.M.S. Challenger enabled me to study the anatomy of at least some genera (*Nymphon* and *Colossendeis*), I eagerly made use of this opportunity; in the first place, in the hope of increasing our knowledge of the morphological structure of the group, so that the question of their position in the zoological system might perhaps be settled; and in the second place, to try in this way to illustrate the mode of life of those deep-sea animals which belong to our group.

My original intention of going through the whole anatomy of the Pycnogonids I have given up, seeing that, however good the condition of the material might be, yet in regard to some organs,—intestine, heart, &c.,—and for the histological structure of most organs, it by no means takes the place of fresh material. Moreover, as I learned after a great part of my anatomical researches was finished that Dr Dohrn's Monograph is forthcoming, I determined to limit the publication of my researches to those organs which had suffered least from having been in alcohol for so many years. These are the integument, with its glands; the nervous system, with the sensory organs; and the reproductive organs. In regard to the intestine, the heart, &c., only some incidental observations were made, which, in so far as they are thought important enough, will be recorded also.

1. *Integument.*—The integument of the Pycnogonids is only known from the publications of Zenker (1855),[1] myself (1877),[2] and Dohrn (1879).[3] Zenker was the first to observe the numerous cavities in the chitinous cuticle of *Pycnogonum litorale*. I, however, had the good fortune to demonstrate that these cavities communicated by

[1] Zenker.—Untersuchungen über die Pycnogoniden, Müller's Archiv, 1852.
[2] Hoek.—Ueber Pycnogoniden, Niederländisches Archiv für Zoologie, iii., 1877.
[3] Dohrn.—Neue Untersuchungen über Pycnogoniden, Mitth. Zool. Stat. Neapel., i., 1879.

means of very narrow canals with the exterior, and that they occur in all the genera of Pycnogonids (at least in those I had then studied—*Nymphon*, *Pallene*, *Phoxichilidium*, and *Pycnogonum*). Moreover, I pointed out that as no respiratory organs are present in the Pycnogonids, respiration must necessarily be integumentary; it was my conviction in 1877, as it is still, after a minute investigation of the Challenger material, that the principal function of these canals is to serve for respiration. Contrary to this opinion, Dohrn asserts that the cavities, with the pore-canals, which he says, were rightly described by me, "zur Aufnahme von Hautdrüsen dienen." To settle this question I investigated the structure of the integument of many species belonging to different genera. I studied it in *Nymphon hamatum*, *N. longicoxa*, *N. brachyrhynchus*, and *N. brevicaudatum*; in *Colossendeis leptorhynchus*, *C. gigas*, and *C. proboscidea*; in *Ascorhynchus glaber* and *A. orthorhynchus*; in *Pallene australiensis*; and in *Phoxichilidium patagonicum*, *P. pilosum*, and *P. insigne*.

Notwithstanding that my researches were especially directed to this point, I only once succeeded in observing the glands referred to by Dohrn, and although I grant it is possible that in some cases this may be owing to the condition of the animals, yet I feel sure that as a rule these glands are not present.

A short description of the integument may find a place here. It always consists of a subcuticular layer (epithelium), and of the chitinous cuticle. The subcuticular epithelium is of a protoplasmic nature, with nuclei imbedded in it[1] (Pl. XVI. figs. 1 and 17, *f*); the chitinous cuticle in the different species shows a very different thickness, and always presents a stratified appearance. It is never calcified, and, as a rule, is coloured yellow by picrocarmine. Often, however, it shows two distinct laminæ; an internal very thick one, coloured violet by the picrocarmine, and consisting of numerous alternately lighter and darker strata, and a comparatively thin external one, which assumes a yellow colour when treated with picrocarmine (Pl. XVI. fig. 1). To strengthen the often extremely long and slender joints of the legs (especially the thighs and the two tibial joints), the chitinous cuticle is often furnished internally with one (*Ascorhynchus glaber*, Pl. XVI. fig. 9) or two (*Nymphon hamatum*, *Phoxichilidium insigne*) longitudinal ridges, which project into the interior of the leg. The form of these ridges on a transverse section is by no means always the same, as may be seen from the figures 6, 9, 11, 16, 17, and 18 on Pl. XVI. The septa of connective tissue, which in most genera divide the cavity of the joints of the leg (*Colossendeis*, *e.g.*, fig. 16, Pl. XVI.), often have a point of attachment in these ridges.

As a rule the chitinous cuticle of the Pycnogonids is perforated by two kinds of cavities, the one of an irregular conical shape, terminating externally in a narrow pore-canal; the other much narrower, and rather more cylindrically shaped, is filled

[1] The subcuticular epithelium of *Pallene australiensis*, Hoek, is richly furnished with a dark brown pigment. I did not observe this in any of the other species.

with a protoplasmic substance, often containing nuclei. No doubt it is the protoplasmic epithelium which fills these latter canals. A nerve passes through them, and terminates at the surface of the cuticle in what Dohrn (*loc. cit.*, p. 38) calls a "Borstenapparat." Dohrn never observed a single seta[1] at the end of these canals; but always two or more (sometimes even a rosette of eight or nine) together. This observation of Dohrn's seems to be most accurate; as a rule I found the integument of the species of *Nymphon* furnished with forked setæ (Pl. XVI. figs 1, 2, 4, 7), one of the setæ being often split again (fig. 3); that of *Pallene australiensis* shows also forked setæ; the integument of *Ascorhynchus glaber* is also furnished with double setæ, which are here extremely small and rudimentary. One of the species of *Phoxichilidium* (*P. patagonicum*) shows a combination of four or five (Pl. XVI. fig. 17), while in another species (*Phoxichilidium pilosum*) two combined setæ are always observed.

In *Colossendeis* setæ are totally wanting; and thus in this respect the genus *Ascorhynchus*, with its rudimentary setæ, stands between *Nymphon* and *Colossendeis.*

According to Dohrn,[2] this pore-canal, which terminates in these forked setæ, "often" takes its origin from one of the integumentary cavities, which he saw filled up with glands. Dohrn therefore considers these setæ as tactile organs, having probably the special function of causing on irritation, by reflex action, the secretion of a poisonous fluid by the glands, which are situated in the conical cavities of the integument. I think this a very ingenious supposition, but I wish to state in opposition to it, that according to what I have seen of the matter—(1) as a rule the cylindrical and narrow pore-canals do not originate in the conical cavities; and (2) that the occurrence of the glands in the conical cavities is the exception, and that, as a rule, these cavities are empty or partly filled up with a protoplasmic substance, nuclei, blood-corpuscles, &c. In the different species of *Nymphon* it hardly ever happens that the pore-canal with the setæ takes its origin in a conical cavity; in the species of *Phoxichilidium* it does not seem to be so rare (Pl. XVI. fig. 17), even in these species, however, it is by no means the rule.

With regard to the form of the conical cavities, in the first place it must be mentioned, that they have a most regular conical shape in the different species of the genus *Nymphon*, and also in some species of *Pallene*. In *Phoxichilidium* they are of a more elongated form, and often a small lateral branch passes from the main canal near the extremity (Pl. XVI. fig. 17, *b*). The genus *Colossendeis* shows these cavities of a much more irregular shape. As a rule every cavity is bifid, and terminates in two narrow pore-canals (Pl. XVI. fig. 12, *c*). The cavities are usually almost quite filled up with protoplasmic substance. In this genus I once observed distinct cells, with large

[1] Huxley calls "setæ" all the hair-like processes from the fine microscopic down to stout spines, which are found on the outer surface of the cuticle (Crayfish, London, 1880, p. 197). I use the word here, and on the following pages, in a much more restricted sense; having already used the words hairs and spines for the integumentary appendages, I call "setæ" those which I consider as being more particularly of a sensory nature.

[2] *Loc. cit.*, p. 38.

nuclei, in these cavities. This was in the first tibial joint of the leg of *Colossendeis leptorhynchus;* however, I think there can be no doubt that these same cells will also be found in the other joints of the legs of this species. Each cell terminates in a long and slender appendage, which probably extends to within a small space of the opening of the canal. Most probably these are the glands which, according to Dohrn, are always present in these integumentary cavities. I have figured these glands in fig. 1 of Plate XVIII.; *i* is a part of the wall of the intestinal cæcum, which runs through the joint; *c, c* are parts of the septa of connective tissue, which seem to form here separate chambers in connection with the different cavities. These chambers contain numerous blood-corpuscles of an irregular spool form, and towards the pore-canal are furnished with two (*d*), in an other cavity three (*d′*) glandular cells, with very large nuclei. The specimen, the integument of which shows these glands, is a female.

Returning to these integumentary cavities, and their ordinary, viz., their respiratory, function, I have still to mention that I found them in many species with many blood-corpuscles in their interior, and that often also a nerve is seen which sends a very thin branch into them. These I observed more accurately in *Colossendeis proboscidea,* Sab. (See later, under peripheral part of the nervous system.)

The number of these cavities is different in the different species. I counted them in transverse sections of the fourth joint of the leg in some fourteen species, belonging to five genera, and compared them with the girth of the joint. This I did to ascertain if there was any relation between the number of these cavities and the depth at which the species lives. That such a relation does not exist, and that the greater or smaller number of these cavities is one of the properties of the natural groups (genera) of the Pycnogonids, is shown, I believe, by the following table:—

Name of the Species.	Circumference in millimeters of the fourth joint of the leg.	Number of integumental cavities in a transverse section.	Number per millimeter.	Depth in fathoms.
Nymphon brevicaudatum, Miers, . . .	3·25	5	1·54	73
Nymphon brachyrhynchus, Hoek, . . .	1·52	22	14·4	83
Nymphon robustum, Bell, ...	4·6	27	5·9	458
Nymphon longicoxa, Hoek, ...	2·35	12	5·1	1100
Nymphon hamatum, Hoek, ...	3·47	37	10·7	1488
Ascorhynchus orthorhynchus, Hoek, . .	3·4	90	26·5	130
Ascorhynchus glaber, Hoek, ...	3	56	18·6	1375
Colossendeis proboscidea, Sab. (sp.), . .	10·2	106	10	540
Colossendeis leptorhynchus, Hoek, . .	3·37	63	18·7	1126
Colossendeis brevipes, Hoek, ...	3·15	62	20	2650
Pallene australiensis, Hoek, ...	2·4	20	8·3	79
Phoxichilidium insigne, Hoek, . . .	1·57	41	26	14
Phoxichilidium patagonicum, Hoek, . .	5·2	112	21·5	117
Phoxichilidium pilosum, Hoek, . . .	4·17	45	10·8	1790

When comparing the number of these cavities in the fourth joint of the leg with that of the same organs in a transverse section of the body,—for example, between two lateral processes, where the circumference of the body is in some species nearly the same as that of the fourth joint of the leg,—I observed almost the same number of cavities. This was the case at least in *Nymphon hamatum* and in *N. brachyrhynchus;* whereas in the other species more or less considerable differences were observed, the number of these cavities in some species being greater in the legs; in others, on the contrary, round the body.

With regard to the hairs and spines on the surface of the body, I have already pointed out above that, as a rule, species occurring at great depths are rather smooth, whereas those from shallow water are furnished with numerous hairs and spines. Thus *Nymphon longicoxa* and *N. hamatum* have the surface almost quite destitute of spines; *Nymphon brevicaudatum* and *N. hirtipes* occurring at moderate depths, the former not exceeding 120 fathoms, the latter never reaching 300 fathoms, and generally found in considerably shallower water are the most hairy species of the genus. On the contrary, *Nymphon brachyrhynchus,* occurring at depths not exceeding 120 fathoms, is almost as smooth as *Nymphon hamatum.*

The species of *Colossendeis,* and especially the three more accurately studied by me, show almost a perfectly smooth surface. The sensory setæ are wanting also in these species; and the few spines which are present are very short and conical (Pl. XVI. fig. 13). Of these three species, two are true deep-sea inhabitants; but the third (*Colossendeis proboscidea,* Sab. (sp.), as a rule, is found at a depth not exceeding 200 fathoms. Of the species of *Ascorhynchus,* the smooth *A. glaber* is found at a depth of 1375 fathoms; but the surface of *Ascorhynchus orthorhynchus* is also not very hairy, yet this species occurs at a depth of only 130 fathoms.

The shallow water genera *Achelia* and *Ammothea* are extremely hairy, whereas in the genus *Phoxichilidium* some of the deep-sea species (*P. pilosum* and *P. mollissimum*) show a particularly hairy surface. Both the spines and the setæ are in these species of a very remarkable length. Finally, *Pallene australiensis,* occurring at a depth of 38 to 120 fathoms, shows again the smooth surface of a true deep-sea species.

The form of these spines is also very different, but I think it is not necessary to describe them. In some species the spines are not smooth, but serrated; as, *e.g.*, in the case of *Nymphon brevicaudatum,* Miers, and *Pallene australiensis,* Hoek (Pl. XI. figs. 6, 7); and as spines having a very curious shape I have pointed out already those of the sixth joint of the ovigerous leg of *Nymphon longicoxa.* No doubt, these must be of great use to the animal in holding the egg-masses, and perhaps also in furnishing a good point for the young ones to cling to. Particularly interesting are also the so-called denticulate spines in the four last joints of the ovigerous legs of most species. I may refer to the descriptive part of this report for an account of their extremely different forms, their numbers, and their arrangement.

Different as the forms of these spines may be, their minute structure is always the same, and, I think, quite identical with that of any other spine. The cuticle is perforated at the place where the spine is inserted, and a thin and flexible part of this cuticle keeps the spine in its place; a socket is thus formed in which the spine easily moves. The spine itself is, near its insertion, cylindrical and hollow, and its cavity is entirely or partly filled with a protoplasmic substance, which is in continuity with the epithelium of the integument. Towards the extremity the spine is flattened, chitinous, and no longer hollow; the exterior margin of this flattened part is serrated (*Nymphon*), or provided with extremely small teeth (*Colossendeis*). Originally I considered these spines as being of a sensory nature; but afterwards, as I was convinced of their chitinous composition, I changed my opinion. However, as it is not difficult to trace a nerve, at least in some of the more transparent species, penetrating these spines, they may still be considered as, to a certain extent, organs of feeling. On the other hand there are, perhaps, far more important functions to be fulfilled by the ovigerous legs with the aid of these denticulate spines, viz., those of seizing the food, and, last, not least, of holding the animal of the other sex during the act of copulation. In most species where denticulate spines occur the four last joints of the ovigerous legs often lie rolled up spirally, with the rows of denticulate spines turned inwards. These joints if wound round one of the legs or any other part of the body of the animal with which it copulates, would necessarily secure a very strong adhesion in consequence of the rows of spines.

In close relation with the integument are the glands, which occur in different appendages of the body.

1. The glands of the palpi. These I observed in *Discoarachne brevipes*, where they occur in the third joint of the palpi, and probably their secretion is poured out through a sieve-like perforated spot at the end of the second joint (Pl. VII. fig. 10). In the palpus of *Ascorhynchus* such a gland is also present. It is situated in the fifth joint, and has the form of a long sack, whose wall is lined by small and very numerous glandular cells. It is attached to the wall of the joint of the palp by means of numerous threads of connective tissue, and it opens towards its distal extremity by means of a rounded pore. In *Ascorhynchus orthorhynchus* this pore is placed at the tip of a small conical excrescence; but in *Ascorhynchus glaber* I did not observe this knob. Probably the same glands occur also in other genera—*e.g.*, in *Colossendeis*—but I could not ascertain their presence.[1]

2. The glands of the ovigerous legs. These I observed in *Nymphon*, but their minute structure can only be studied in fresh specimens. They open into a small pore, not far from the beginning of the fourth joint of the leg. Each gland seems to consist of the

[1] The glands of the palpi are mentioned in Dohrn's paper of 1879. He says of the nerve of the palpus: "Er umfasst auf seinem Laufe ein sonderbares, bisher unbekannt gibliebenes Excretionsorgan" (*loc. cit.*, p. 31).

true glandular part and of a wider part, which acts probably as a receptaculum and opens into the fine pore.[1]

3. The glands in the fourth joint of the legs of the males. These I observed in the following species :—*Nymphon hamatum*, *Nymphon brachyrhynchus*, *Ascorhynchus glaber*, *Colossendeis leptorhynchus*, *Colossendeis proboscidea*, *Colossendeis megalonyx*, *Oorhynchus aucklandiæ*, *Phoxichilidium insigne*, and *Pallene australiensis*. Whether or not they occur in the thighs of the males of all the species I dare not assert. I can only say that I did not find them in the thighs of the following species :—*Nymphon robustum*, *N. brevicaudatum*, *N. longicoxa*, *N. grossipes*, and *Colossendeis gracilis*. This may, however, be the consequence of these glandular masses being present only during a short period of the year—for example, only in the breeding season.

These are the glands which were observed by Dohrn. According to him (*loc. cit.*, p. 36) they occur only in the male sex, and are found in the fourth joint of the legs, viz., in those joints in which in the females the ovaries are most strongly developed. Dohrn, moreover, tells us that these glands are extremely variable in their appearance ; while in *Ammothea* they are furnished with a single duct only, in *Phoxichilus* there are fifteen smaller openings. Dohrn supposes that the function of these glands is to secrete a viscous fluid, wherewith the males agglutinate the eggs which have been laid by the females, and attach them to their ovigerous legs.

As to the function of these glands, I was unable to make any observations from the material preserved in spirits and brought home by H.M.S. Challenger. With regard to their structure the following may be stated :—The glands are always composed of a skeleton of connective tissue, the meshes of which are or are not filled with nucleated cells, which doubtless are the true glandular cells. When these glands have the meshes filled up with the nucleated cells (Pl. XVI. figs. 5 and 10), the skeleton of connective tissue is not easily discerned ; while in those cases in which the meshes are empty (Pl. XVI. fig. 15) the structure of the connective tissue is easily observed. In the form of the glandular cells small differences were also observed. In *Ascorhynchus glaber*, they are fusiform and pointed at both extremities ; in *Nymphon hamatum*, they are rounded, but in both cases distinct nuclei are present. A considerable difference, moreover, is seen in the greater or less degree of concentration which the glandular masses had undergone. In *Nymphon hamatum* and in *Ascorhynchus glaber* the gland in the fourth joint (which, however, in the latter species is also present in the fifth joint of the leg) forms only a single mass, which runs through the whole joint and opens at the one side in a row of pores, each of which is placed at the tip of a chimney-like process. As seen in fig. 6, the gland in *Nymphon hamatum* almost extends on the one side of the leg, between the intestinal cæcum and the

[1] These glands are also observed by Dohrn ; he calls them " ein zweites noch grösseres Excretions- (oder Drüsen ?-) Organ (*Ibid.*).

wall, from the one longitudinal ridge to the other; whereas in *Ascorhynchus glaber* (fig. 9) the row of pores is placed almost exactly opposite to the single but very strong ridge.

In *Pallene* and *Phoxichilidium* the structure and the position of the glands show nothing particularly interesting. In *Pallene* there are many pores, in *Phoxichilidium insigne* only a single pore at the end of the joint, placed at the tip of a conical excrescence (Pl. XVI. fig. 18*k*). The structure of these glands in *Colossendeis* is extremely interesting. In the three species of this genus in which I studied them, *Colossendeis leptorhynchus*, Hoek, *Colossendeis megalonyx*, Hoek, and *Colossendeis proboscidea*, Sab. (sp.), the gland consists of very numerous more or less isolated parts of a rounded or more longitudinal shape, each of them opening separately by a distinct pore, or (*Colossendeis proboscidea*) three or four opening together in a single pore. In fig. 14 on Pl. XVI. I figure a part of the integument of *Colossendeis megalonyx* magnified; in fig. 15 of the same plate a part of the integument of *Colossendeis leptorhynchus* is shown. The glands seem to correspond with a wide vesicle (*o*), in the interior of which a narrow canal (*p*) lies wound spirally; this canal is easily traced till it opens at the pore. Those conical cavities into which the glands are seen penetrating are much wider than the others. For the structure of the gland itself the specimen of *Colossendeis leptorhynchus* which I investigated was not all I could have wished. On a transverse section it looks quite as if all the original glandular cells had dropped from the connective tissue, this tissue itself being the only part that remained as an empty skeleton. Perhaps the state of preservation is to a certain extent the cause of this. The male specimen of *Colossendeis proboscidea*, in which also I studied these glands, was in a much better condition. Plate XVIII. fig. 2 shows the distribution of the glands (*g*) over nearly half the inner circumference of the skin of the fourth joint. Moreover, in fig. 3 a small part of this skin is figured more strongly magnified with the glands opening into one of the pores. The gland itself (*g*) shows a dense ball of round and nucleated glandular cells. A comparatively wide and very transparent canal extends from the gland to the interior of one of the integumentary cavities (*c*), and a very narrow duct (*d*), which is irregularly rolled up, runs through this wide canal till it reaches the pore at the end of the cavity. When studying a part of the skin of the leg from the interior it is easily seen that three or four of these glandular bodies send their ducts into the same integumentary cavity. From the beautifully developed net-work of nerves and ganglionic plexuses, which extends over the whole inner surface of the integument, distinct nerves are seen arising and penetrating the cavities or innervating the glands.

Finally, I wish still to mention the curious manner in which these glands of the fourth joint of the male open in *Oorhynchus aucklandiæ*, Hoek. A very long cylindrical appendage is inserted on the fourth joint a little behind the middle. The gland opens at the tip of this appendage by means of a very long duct, which shows

a distinct swelling (a kind of receptaculum) near the beginning.[1] About the structure of the gland itself in this species I have no observations to communicate.

2. *Nervous System.*—Of the different systems of the Pycnogonida the one most eagerly studied is, without doubt, the nervous system, and this is quite natural, because it has been rightly considered, that if any system could be expected to shed light on the affinities of the Pycnogonids with the other Arthropoda, it would be the nervous system.

Among the more important papers on the subject, those of Zenker, Semper, Dohrn, and myself may be mentioned. The way in which Zenker (*loc. cit.*) treats of the nervous system of *Nymphon* is not a very happy one, as he describes and figures it as consisting of a supra-œsophageal ganglion and four thoracic ganglia. The account given by Semper[2] of the nervous system of this genus is much more accurate. He tells us that in *Nymphon* the supra-œsophageal ganglion innervates the mandibles and the eyes, and that the first of the five thoracic ganglia furnishes nerves to the proboscis, to the palpi, and to the ovigerous legs, while the four following ganglia give off nerves to the four legs. The number of thoracic ganglia is, according to Semper, also five in *Pallene* and in *Achelia*, on the contrary only four were observed by him in three species of *Phoxichilidium*. In my paper the optic nerves of *Pycnogonum* are described, and the number of ganglia in *Nymphon* is given as five, in *Pycnogonum* as four.[3] We find in Dohrn's latest paper (*loc. cit.*, p. 37) a much more detailed description of the structure of this system. The supra-œsophageal ganglion innervates the mandibles, and, moreover, gives off an azygous nerve, which dorsally innervates the proboscis, and forms a ganglion at about one-third from the extremity of the proboscis. The first thoracic ganglion gives off three pairs of nerves; the first pair arising from the ganglion a little outside and below the insertion of the circum-œsophageal commissures, innervates the lateral parts of the proboscis. Like the azygous proboscideal nerve, they form ganglia at about one-third from the extremity of the proboscis, and these three ganglia are connected by commissures, which thus form a secondary œsophageal ring. The second pair innervates the so-called palpi; the third arises from the ganglion laterally towards the posterior part, it innervates the ovigerous legs. Moreover, Dohrn observed that this first thoracic ganglion not only in the genera furnished with palpi and ovigerous legs, but also in those forms which have lost their palpi and even in the females, which have lost also their ovigerous legs, consists of three nuclei of "fibrillären Punktmasse," each of which gives off the fibres for the nerves respectively of the proboscis, palpi and ovigerous legs. In a young stage of the embryological development, Dohrn made the observation that the first ganglion really consisted of two

[1] Such a long appendage, at the tip of which the gland opens, occurs also in *Ammothea* (Dohrn, *loc. cit.*, p. 36).

[2] Semper (C.), Über Pycnogoniden und ihre in Hydroiden schmarotzenden Larvenformen (Arbeiten a. d. Zool.-Zoot. Institut in Würzburg, i., 1874, p. 278).

[3] *Loc. cit.*, p. 249.

not quite separated pairs of ganglia. Finally, Dohrn states in the same paper that besides the five (six) double ventral ganglia there are two others, which, however, in some genera, totally disappear, and in other genera are preserved only in a rudimentary condition. Accordingly, Dohrn observed immature stages of *Phoxichilus*, in which, behind the sixth ventral ganglion, were present two distinctly separated, although much smaller, pairs of long ovate ganglia. Of these the first pair gives off no nerve, and the second pair the two nerves for the abdomen.

For my observations with regard to the nervous system of the Pycnogonids, I made use of the following specimens from the material of the Challenger Expedition:—one of *Nymphon hamatum*, one of *Nymphon brachyrhynchus*, two of *Nymphon brevicaudatum*, Miers; numerous specimens of *Nymphon robustum*, Bell; one of *Colossendeis leptorhynchus*, one of *Colossendeis megalonyx*, and one of *Colossendeis proboscidea*, Sab.; finally, one of *Phoxichilidium pilosum*. What I tried to ascertain in my investigations was, in the first place, the innervation of the cephalic appendages and of the proboscis, in the second place the structure of the first thoracic ganglion, in the third place that of the last thoracic ganglion, and the presence or absence of the two rudimentary abdominal ganglia. In how far I have been successful in this may be judged from the following:—

The nervous system consists in all species of Pycnogonids of a supra-œsophageal ganglion, an œsophageal commissure, and five (seldom four) thoracic ganglia. The supra-œsophageal ganglion is situated in the cephalothoracic segment; however, its place varies greatly with the form of the segment, and therefore it even shows small differences in the different species of one genus. The differences in the different genera are more considerable. In the genus *Nymphon* it is, as a rule, placed towards the hinder extremity of the cephalic part of the cephalothorax, below the oculiferous tubercle, and above the insertion of the two ovigerous legs. In the genus *Colossendeis* this ganglion is found nearly in the middle of the cephalic part of the cephalothoracic segment, which part is usually separated (distinctly in *Colossendeis leptorhynchus, e.g.*) from the remaining part of the segment by means of a constriction; the oculiferous tubercle is here exactly above the ganglion. In *Phoxichilidium* the ganglion is found also above the insertion of the ovigerous legs; but the oculiferous tubercle is in most species of this genus situated quite anteriorly, on that part of the cephalothoracic segment which overhangs the proboscis. As a rule the shape of this ganglion is round (Pl. XVIII. fig. 6), but in *Colossendeis* the comparatively small ganglion is much broader than long (Pl. XVIII. fig. 4). Whereas, in the other genera the two œsophageal commissures are very short, run parallel to each other, and enclose a narrow canal through which only the œsophagus passes (Pl. XVIII. fig. 11 C.), in *Colossendeis* (I observed it in *Colossendeis leptorhynchus*, Hoek, and in *Colossendeis proboscidea*, Sab., sp.) this canal is very wide (Pl. XVIII. fig. 4), the commissures which connect the supra-œsophageal ganglion with

the first thoracic ganglion are very long, and through the wide canal formed by these not only the intestine passes but also two large muscles (Pl. XVIII. fig. 7), which serve for the movement of the proboscis, and run from the posterior margin of the proboscis to the hinder part of the dorsal surface of the cephalic part of the cephalothorax. These muscles are anteriorly narrow, and grow considerably broader towards their extremity, so that their shape is rather triangular. The nerves which arise from the supra-œsophageal ganglion are the same in *Nymphon*, *Phoxichilidium*, and *Colossendeis*. To the front three comparatively strong nerves are always present.[1] Of these, that nerve which is placed in the middle takes its origin in the ventral surface of the ganglion, a little behind the front margin. This middle nerve is the azygous proboscideal nerve. It runs close to the dorsal surface of the proboscis, and gives off at rather irregular distances extremely small nerves, which innervate the integument. At a distance of about one-fourth of the total length of the proboscis in *Nymphon*, and of about one-eighth of the same length in *Colossendeis*, it enters the ganglion (Pl. XVIII. fig. 8), which, no doubt, has already been observed by Dohrn. The two mandibular (antennary) nerves arise from the front margin of the supra-œsophageal ganglion; they are nearly (in *Nymphon* and in *Phoxichilidium*) of the same strength as the azygous proboscideal nerve. First they are slightly divergent, then they approach each other again so as almost to touch the azygous proboscideal nerve, then they separate again and direct themselves forwards and a little upwards, running in the mandibles very close to that part of the dorsal surface which is nearest to the mandible of the other side (Pl. XVII. fig. 4, *n.m.*). In regard to the farther course of the mandibular nerve I could only observe that it divides into two branches. These nerves are not totally wanting in the genus *Colossendeis*, and considering the case of *Colossendeis gracilis* with its distinct mandibles, we need not wonder at this. Yet the nerves are very short and represented only by rudimentary branches (Pl. XVIII. fig. 4, *m*). (Those of the interesting specimen of *Colossendeis gracilis* I was unable to observe without dissecting the specimen.)

With regard to the innervation of the eyes, I observed distinct nerves arising from the supra-œsophageal ganglion. These I have described already in my paper on Pycnogonids, published in 1877, and their presence is confirmed by Dohrn's observations. Dohrn (*loc. cit.*, p. 37) says that they arise from the sides of the ganglion, and that they are widely separated from one another. Moreover, Dohrn tells us that there are two of them, and that they divide and innervate the eye in a peculiar way. I studied the innervation of the eyes in *Nymphon brachyrhynchus*, *N. strömii*, *N. robustum*, and in *Colossendeis proboscidea*. The latter species is a blind one; its eyes are represented only by a small

[1] In the figure I give of the nerves arising from the supra-œsophageal ganglion of *N. robustum* (Pl. XVII. fig. 4), besides these three nerves two thinner ones are figured. These, however, are not present, as I ascertained after the plate was printed off. Although I have given myself much trouble in trying to determine what it was I had mistaken for nerves, I have not succeeded. The thin threads have the appearance of narrow ducts; they extend backwards to behind the supra-œsophageal ganglion and pass between this ganglion and the upper surface of the œsophagus.

rounded spot distinguishable by its transparency. The optic nerves are represented by two strong bundles of nerves, arising as in *Colossendeis megalonyx* (Pl. XVIII. fig. 4, *o*) laterally from the dorsal anterior surface of the ganglion. These nerves divide into stronger and feebler branches, and the latter have small ganglia between them. Such small ganglia are present also on the interior surface of the small transparent spot representing the rudimentary eye. They are in relation partly with the nerve fibres of the so-called optic nerve, partly with the complicated system of nerves and ganglia, which covers in this species as in the other species of the same genus, the internal surface of the integument. In this species of the genus *Colossendeis*, and from what I have seen of the matter, the same is the case in *Colossendeis leptorhynchus* and *C. megalonyx*, the optic nerve-bundles are really integumentary nerves, giving off the nerve-branches, which, as will be shown hereafter, extend all over the inner surface of the integument, having everywhere ganglia between them, and, as a rule, at small distances from one another.

I feel inclined to consider the condition of the eye, and of its innervation as described for *Colossendeis proboscidea*, as the original condition in the Pycnogonida. As an example of the most highly developed condition, I wish to describe that of *Nymphon brachyrhynchus*. Dorsally the supra-œsophageal ganglion gives off two nerves, which are at their origin quite covered over by ganglion cells (Pl. XVIII. fig. 11 C. *o'*). Where they arise from the ganglion, the distance between the two nerve-bundles is not very considerable; they diverge slightly till they reach the base of the oculiferous tubercle. Here each of these nerve-bundles divides into two branches which run horizontally, the one towards that part of the integument which is before, the other towards that behind the oculiferous tubercle. On reaching the integument each of these two branches divides into numerous smaller nerves and nerve-fibres; moreover, they send upwards numerous nerve fibres, which penetrate the oculiferous tubercle and extend till they reach the outer wall of the eye. There can be no doubt, therefore, that the eye is innervated by nerve-fibres not united together so as to form a distinct optic nerve.

The same mode of innervating the eye I observed in *Nymphon strömii*. For the study of the innervation of the rudimentary eye of *Nymphon robustum* I got good preparations also. A part of one of these is figured in Plate XVIII. fig. 5. We have the same nerve-bundles covered by ganglionic cells; they do not, however, divide immediately into the stronger integumentary and smaller optic nerves, but before doing so they enter a comparatively large ganglion (fig. 5, *g*) from which these nerves are seen arising. This same ganglion gives off also the nerves for the setæ, which in this species are present in considerable number at the tip of the oculiferous tubercle.[1]

[1] This quite corresponds with Dohrn's observations, that the optic nerves give off also branches to the curious organs observed by him between the eyes. I believe these organs are rudimentary in *Nymphon*, in *Colossendeis proboscidea* they are totally wanting.

While the eye of *Colossendeis proboscidea*, Sab., must probably be considered as the most primitive condition, that of *Nymphon robustum* is undoubtedly a degenerated form. In the innervation of the different stages of development of the eye of the Pycnogonids I believe I have pointed out one common feature, viz., that the two nerves arising from the supra-œsophageal ganglion may be only partly considered as optic nerves, and that it is much more in accordance with the facts to call them integumentary nerves, branches of which have assumed the function of optic nerves. For the investigation of the development of the organs of sense and especially of the eyes, I believe the study of the Pycnogonida will yield in future very interesting results.

The number of thoracic ganglia in *Nymphon*, *Colossendeis*, and *Phoxichilidium pilosum* is five. Those of *Colossendeis* (*C. proboscidea*, Sab., sp.) are figured in Plate XVII. fig. 2; those of *Nymphon robustum*, Bell, in fig. 3 on the same plate. In these three species the first ganglion (better called the first ganglionic mass) is separated from the second by two distinct commissures, and in *Nymphon robustum* and *Phoxichilidium pilosum* even the outward form of the ganglion shows its complex nature; on a longitudinal section it is seen to be composed of two distinct ganglia. This anterior ganglionic mass supplies the two ventral parts of the proboscis, the palpi, and the ovigerous legs; three pairs of strong nerves are given off by the ganglion, which, judging from its anatomical structure and from its development (*vide* Dohrn, *loc. cit.*, p. 34, and also in this report *sub* embryology, with Pl. XIX. figs. 11 and 13) is composed of only two pairs of original ganglia.[1] For a long time I was greatly puzzled with this fact, until the study of the nervous system of *Colossendeis* dispelled my doubts.

In fig. 4 of Plate XVIII. I figure the supra-œsophageal and first thoracic ganglia of *Colossendeis megalonyx*. The latter gives off the two nerves for the ovigerous legs (*o*), the nerves for the palpi (*pa*), which in the same way as the nerves for the legs immediately divide into two branches, and in the third place the two nerves for the proboscis (t''). Moreover, a fourth nerve (t') is observed, which serves also for the innervation of the proboscis, and the fibres of which arise from the same part of the ganglion as those of the main proboscideal nerve. For a short way these fibres run parallel with the fibres of the commissures, so that this first pair of proboscideal nerves seems to arise from these commissures.[2] These same nerves are also present in

[1] On page 32 of the same paper, Dohrn asserts that in the first thoracic ganglion three nuclei are present of the well-known "fibrillären Punktmasse." This does not agree with what I have seen in the three genera I studied, nor does it agree, I believe, with what Dohrn himself says on page 34.

[2] In fig. 2 on Plate XVII. the ventral part of the nervous system of *Colossendeis proboscidea*, Sab., sp., is figured. From the first thoracic ganglion arise the nerves for the ovigerous legs (*n. o. l.*), and a strong nerve (the palpus nerve) dividing into two branches (*n. pr.* and *n. p.*). The most anterior, and at the same time most dorsal, part of this ganglion, from which arise the two pairs of proboscideal nerves, and the commissures, has not been figured, having been removed during the preparation.

Nymphon in a much more rudimentary state. Nobody would conclude, however, from their presence that the first ganglion was originally composed of four ganglia; but the supposition of its being formed of three nuclei loses at the same time much of its value, and the ventral part of the proboscis must be considered as being innervated by the same original ganglion as that which gives off the nerves for the palpi.

I believe there can be no doubt that we have here the original condition of the nervous system; at the same time this fact may be considered as suggesting the opinion that the palpi originally belonged to a pair of appendages which coalesced to form the two undermost of the three parts of which the proboscis is composed.

The two front nerves of the first thoracic ganglion in *Nymphon* and *Phoxichilidium*, and the strongest of the two front nerves of the same ganglion in *Colossendeis*, enter the proboscis and run forwards exactly in the middle of the two ventral parts of the proboscis, which I compared (note on p. 14) with the carpels of a monocotyledonous fruit. These nerves I call the paired proboscideal nerves. They end, like the azygous proboscideal nerve, by entering a ganglion, placed at about the same distance from the end of the proboscis as the ganglion of the azygous proboscideal nerve. These three ganglia are united by a ring, which runs between the outer wall of the proboscis and the chitinous wall of the œsophagus, among the numerous muscles which run from the one wall to the other.

So far my description quite agrees with that of Dohrn, as given above. However, a considerable difference arises from the fact that the ganglia which were seen by Dohrn are not to be considered as ganglia of the azygous or paired proboscideal nerves, but as being really the terminal ganglia of three strong nerve bundles, composed of nerve fibres and ganglia, which run longitudinally below or above the three stout proboscideal nerves, so that they lie between these nerves and the wall of the œsophagus. The discovery of these three ganglionic nerve bundles has been very fortunate. It is curious that they have hitherto been always overlooked, and especially that Dohrn did not observe them. But then it must be considered that these nerve bundles are placed among numerous muscles running over and beneath them, and making a preparation totally impossible. A successful longitudinal section, made exactly above or below a bundle, is the only way to detect it. I call these bundles ganglionic, for although I do not believe that their function is analogous with that of the sympathetic system of higher animals, yet their structure shows in general the same relative distribution of ganglion cells and nerve fibres as in the case of the ganglionic system of higher animals.

Fig. 6 on Plate XVIII. shows the position of these nerves in the proboscis; while fig. 8 shows a part of one of them more strongly magnified. Each of them (g) consists of a strong bundle of nerve fibres, which, posteriorly at irregular, anteriorly at more regular distances, are surrounded by groups of ganglion cells. Thus each of the

cords has the appearance of a row of ganglia connected by bundles of nerve fibres. The size of these ganglia is not quite the same over the whole cord, the foremost being slightly larger than those placed more posteriorly. As to their shape, I observed the following two different types. In some of the ganglia the cells are placed on both sides of the bundle, which passes through it, and these ganglia have a very regular rhomboidal form. The other type is represented by those ganglia in which ganglion cells are to be observed only on one side of the nerve bundle, and which accordingly show a triangular form. The triangular ganglia seem to be more numerous in *Colossendeis*, the rhomboidal form in *Nymphon;* in both genera, however, the stout ganglia, which are placed in the front part of the cord, and in the first place the comparatively large ganglion (figs. 6 and 8 *y*) observed by Dohrn are of a distinct rhomboidal form.

The form of the ganglion is, of course, determined by the number of nerves which branch off from it. The different ganglia give off besides numerous smaller nerves, one (in the triangular form) or two (in the rhomboidal) stouter nerves. These run in the foremost part from the one ganglionic bundle to the two others, and form nerve-rings (fig. 6, $a^{I.}$ $a^{II.}$ $a^{III.}$ &c.), of which the secondary œsophageal ring (figs. 6 and 8 *a*) observed by Dohrn is the first and the stoutest. In *Nymphon robustum* I observed five or six of these nerve rings, but in *Colossendeis* they are still more numerous.

With regard to the three stout proboscideal nerves, which have been observed already by Semper and Dohrn, and which, according to the latter author, terminate in the three ganglia (the front ganglia of my ganglionic bundles), I have ascertained that they are connected with the ganglionic bundles in the following way :—They run superiorly to and quite independently of the ganglionic bundle, till they reach the last but one ganglion of that bundle (fig. 8 *u*). This they enter, their fibres passing through it and contributing to the comparative thickness of that part of the bundle which unites the last but one and the last of the ganglia (fig. 8 *y*). However, it is very probable that at least some of these fibres extend beyond the last of the ganglia. I am not quite certain whether perhaps, a union of the ganglionic cord with the proboscideal nerves does not also take place posteriorly. As I have stated already above, the proboscideal nerve gives off branches; and about the middle of the proboscis of *Colossendeis proboscidea*, Sab. (sp.), on both sides of the stouter middle nerve two thinner cords run parallel with it in its immediate neighbourhood; these are branches of the middle nerve. Investigating the first part of these lateral branches, close to their origin from the main proboscideal nerve, I once observed (in *Colossendeis megalonyx*, Hoek) very small ganglia with thin nerve threads running along this nerve without, however, exchanging fibres; these are, possibly, the end branches of the ganglionic bundle. While the origin of these branches and their connection with the proboscideal nerves is so easily noticed, with regard to their termination I only observed that the bundles, when approaching the end of the proboscis,

become thinner and thinner, the ganglia smaller, and the lateral branches arising from the ganglia more numerous and much thinner and shorter. This is quite in correspondence with the number of muscles which these ganglia innervate; whereas these in the front part of the proboscis are stouter, and separated by distinct longitudinal intervals, in the posterior part they are thinner, and placed almost in an uninterrupted row.

This brings us quite methodically to the function of these ganglionic nerve-bundles. In the vertebrates we can distinguish by the microscopical structure sympathetic ganglia and nerves from those of the cerebro-spinal system, but in the invertebrata this is by no means so easy. In the first place, we must consider the function of the part of the nervous system in question. The ganglia and the nerves of my three ganglionic bundles innervate the striped muscles of the proboscis. Unstriped muscular fibres are by no means rare in the muscular tissue of Pycnogonids,[1] but even if they were quite wanting, as they seem to be in the muscular tissue of the Crayfish,[2] those of the proboscis ought to be considered as voluntary fibres. Moreover, the action which the food undergoes in the proboscis by means of these fibres is of a purely mechanical nature. Chemical action does not take place in it, therefore comparison of these ganglionic bundles with the sympathetic system of higher animals is impossible.

The morphological explanation of their presence is by no means so easily given. The following reasoning must be considered as an attempt only. The proboscis of the Pycnogonida in the form in which it presents itself should not, of course, be considered as a new organ, only present in this class of Arthropoda. It is only an organ or a combination of organs under a new form, modified under the influence of surrounding conditions. Considering for a moment the supposition right, that it results from the union of three parts, an azygous one placed partly above and partly before the mouth (the upper lip), and two others placed below and behind the mouth, the manducating parts of the mandibles, of which the palpi in that case may be considered as the feelers; then we have in the three nerves, the first of which is given off by the supra-œsophageal ganglion, and the two others arising from the first thoracic ganglion, the normal nerves for the innervation of these parts. With the union of these parts to form a proboscis) and I believe this argument will hold good also if we prefer another homology for these parts), and the predominance of the manducating function of this proboscis, evidently quite a new part of the nervous system, will make its appearance; and it is not difficult to imagine its probable origin.

In the chitinous wall which lines the canal of the proboscis, and which is furnished with rows of very numerous teeth and spines, we have, no doubt (morphologically), a continuation of the integument, so that its inner surface corresponds with the outer surface of the body, while its outer surface, to which the muscles are attached, is the homologue

[1] *E.g.*, in the wall of the vasa efferentia of the males, &c.

[2] Huxley, The Crayfish, p. 181.

of the inner surface of the skin. Now, this inner surface of the integument both of the body and the legs, especially in species of the genus *Colossendeis*, is richly furnished with ganglia, which spread all over it, and are connected with nerves. They are so very numerous as to form a continuous network of ganglia and nerves, their function being, I believe, to innervate the cavities of the integument, for which I have suggested a respiratory function. There can therefore be no difficulty in supposing that the ganglia of my ganglionic bundles are derived from originally integumentary ganglia, and that their high development is to be attributed to the changed functions of the parts which surround the mouth.

While these same ganglionic bundles, in a more or less developed state, are found in all species and genera of Pycnogonida, it is very probable, I believe, that in the other classes of the Arthropoda their homologues[1] will be sought for in vain. The shape of the terminal ganglia, of which the dorsal one is the largest, is best seen from the drawing (Pl. XVIII. fig. 8). Of the nerves which arise from it, two run in an oblique direction (one to each side), these enter again (at least in *Nymphon*) a small ganglion, from which nerves are given off to the tactile organs placed in the so-called lips of the proboscis. Of these small ganglia, those two, which are placed on both sides of one of the lines of union of the three proboscideal parts, are again connected by means of a nerve string. The tactile organs consist of a small tuft of hairs placed just at the end of the chitinous list which marks the place of union of two of the proboscideal parts meeting there laterally. Perhaps the nerve fibres of the small nerve bundles, which enter the secondary ganglia and innervate these tactile hair-tufts, take their origin in the three original proboscideal nerves.

Besides the three original nerves and the three ganglionic bundles, two thinner nerves enter the proboscis dorsally. These I observed only in *Nymphon* arising from the supra-œsophageal ganglion. The two thin nerves which in *Colossendeis* run alongside and quite near to the main proboscideal nerve must be considered as branches of this main nerve, and no doubt there are still other longitudinal nerves, which run through the proboscis, and which must also be considered as branches of one of the three main nerves.

What I observed in regard to the remaining part of the nervous system is the following:—The shape of the four thoracic ganglia may be seen from the figures on Plate XVII. The length of the commissures uniting these ganglia is different in different genera, and even in the different species of one genus. In *Nymphon robustum*,

[1] It seems to me that an analogous case is that of the visceral or stomatogastric nerves of the Crayfish, studied by different authors, and investigated recently more accurately by Prof. Huxley (Anatomy of Invertebrated Animals, London, 1877, p. 330), a complex nervous apparatus, serving chiefly for the innervation of the muscles of the mandibles, and for that part of the intestine which has been called by Huxley the gastric mill. This gastric mill of the Decapod Crustacea is placed behind the œsophageal commissures; the analogous apparatus of the Pycnogonids is found in front of the same commissures.

Bell, *e.g.*, the commissures between the third and fourth ganglia are the longest; in *Nymphon brachyrhynchus*, however, those between the second and third are the longest. In *Colossendeis* and in *Phoxichilidium pilosum* the relative length is the same as in *Nymphon robustum*. In all the species and genera I observed the commissures between the last two thoracic ganglia to be shorter, often much shorter, than those between the preceding ganglia. The nerves which arise from these ganglia in *Colossendeis* immediately divide into two branches, whereas in *Nymphon* they only separate after having reached the middle of the lateral process at the end of which the leg is inserted. In *Phoxichilidium pilosum* they again divide immediately after leaving the ganglion. The last ganglion has a truncated form; in most of the genera I studied I observed at least a trace of the presence of the small accessory ganglia (abdominal ganglia) which Dohrn observed in *Phoxichilus*, and which I found beautifully developed in a young specimen of *Colossendeis proboscidea*.

Close to the hinder margin of the ganglion two small excrescences arise from its dorsal surface. They are separated from one another by a small space, and as they unite again at a short distance from the ganglion a round area is left between them. In a full-grown specimen of the same species only a single excrescence was observed, arising from the hinder margin, and I observed it of the same form in *Colossendeis megalonyx* and also in *C. leptorhynchus*. I did not observe it in *Nymphon;* but in the species of that genus which I studied (*N. strömii* and *N. robustum*) I always saw two distinct medullary nuclei in the interior of the ganglion placed close to its hinder margin, behind the large medullary masses from which the nerves for the hindmost pair of legs arise.

According to Dohrn, the nerves which arise from this ganglion are two in number, besides the two stout nerves for the hindmost pair of legs. It is extremely difficult to avoid confounding threads of connective tissue, arising from the neurilemma that surrounds this ganglion with nerves. I have, however, distinctly observed that often four different nerves branch of from the ganglion; in *Colossendeis proboscidea, e.g.*, two smaller ones are given off more in the middle from the dorsal excrescence, and two stouter ones leave the ganglion nearer to the nerves which innervate the fourth pair of legs. Two pairs of nerves arising from the hinder surface are also present in *C. leptorhynchus;* but, strange enough, only one pair (that arising from the excrescence in the middle of the hinder margin) in *Colossendeis megalonyx*. In the genus *Nymphon* the two nerves which arise from the ganglion leave it as one single nerve, and only afterwards divide into two branches. The same difficulty is experienced in ascertaining the presence of nerves branching from the commissures which unite the different thoracic ganglia. These are present, however, in all the genera, and even in all the species I studied. As a rule, they leave the commissures much nearer to the preceding than to the following ganglion, but often also nearly in the middle of the commissures; between the second and third, between the third and fourth, and between the fourth and fifth thoracic ganglion,

distinct nerves are observed arising at an acute angle from the commissures. These innervate the muscles which run from the one segment to the following one.

I give a figure (Plate XVIII. fig. 10) of one of the small ganglia and the nerve fibres arising from it on the inner surface of the integument. I observed these ganglia in *Nymphon* and in *Colossendeis;* they are more numerous in the latter genus, and especially numerous and in a better state of preservation in one of the specimens of *Colossendeis proboscidea*, Sab., dredged last summer north of Scotland. The figure is taken from a part of the integument of a specimen of this species.

To show the minute structure of the ganglia I give in fig. 11 A–F a series of six figures illustrating vertical (frontal) sections through the supra-œsophageal and first thoracic ganglia. As will be easily seen, the sections do not form a complete series, they are only the most interesting out of a series of about twenty. Fig. A represents a section quite at the front of the supra-œsophageal ganglion; a distinct and comparatively thick neurilemma sheath surrounds the whole ganglion, and three distinct medullary nuclei (pointed substance according to Leydig) show the place of origin of the three main nerves. The rest of the section is composed of ganglion cells, with the exception of a small medullary spot at the left side, which does not occur at the other side, and proves that the section is somewhat oblique. Neither the œsophageal commissures nor the first thoracic ganglion are yet to be seen in this section. Fig. B represents a section which passes through the supra-œsophageal ganglion and through the foremost part of the first thoracic ganglion, but not yet through the commissures. Almost the whole section is occupied by the medulla, which forms regular prominences towards the periphery, and only a very small space is occupied by the ganglion cells; *m* is the lobe for the mandibular (antennary) nerve, *o* represents the lobe for the optic nerve, and *x* is a median lobe about the function of which I do not feel quite sure. In section C this median lobe is no longer to be observed, and the optic lobes have here assumed a much more elongated form. In section B the commissures are still totally wanting, but the front part of the first thoracic ganglion, with the medullary nuclei (*p*) for the two infra-proboscideal nerves, are distinct. These in section C are reduced to small lobes, while those for the nerves of the ovigerous legs (*t*) are distinct. In this section the œsophageal commissures are seen, and also the undermost parts of the two optic nerves, which arise from the supra-œsophageal ganglion (*o′*). Their connection with the optic lobes, however, does not occur in this section. Section C passes almost through the middle of the oculiferous tubercle, so that two eyes are placed in front of this section and the two others behind it. Section D represents the last part of the supra-œsophageal ganglion; the hindmost part of the medulla is seen, and the ganglion cells begin again to increase in number. Of the first thoracic ganglion, the section goes through that part of the medullary centrum which gives off the nerves for the ovigerous legs (*l*). In E this medullary centrum is considerably less voluminous, and,

finally, in F only two rounded spots of medulla are left (*co′*), which give off the commissures between this and the second thoracic ganglion.

About the histological structure of the ganglia I wish to be very short. In fig. 12 on Plate XVIII. a longitudinal section is given of the first thoracic ganglion of *Nymphon brachyrhynchus.* A comparatively thick sheet of connective tissue (neurilemma sheath) surrounds the ganglion, and is in continuation with the sheath of the commissure which unites this ganglion with the second thoracic ganglion. Small ganglion cells, each with a distinct nucleus, fill that part of the ganglion which is not occupied by the nerve fibres. These ganglion cells are situated in meshes of connective tissue, they are small and furnished with but little protoplasm; their nuclei are distinct, and show a small and glittering nucleolus.

In a section through the first thoracic ganglion of *Colossendeis leptorhynchus,* it is easily observed, that the ganglion cells are of two different sizes: there are very large ones rich in protoplasm, and furnished with comparatively large nuclei; there are also very small ones, which show only a small quantity of protoplasm. Fibres and sheets of connective tissue are everywhere observed between the ganglion cells; the neurilemma sheath of the ganglion itself is very thick, whether it is to be considered as really double (an outer and an inner neurilemma sheath, the latter of which should be in connection with the connective tissue meshwork of the interior of the ganglion), I have not been able to ascertain.[1]

3. *Eyes.*—Of the organs of sense I paid special attention to the eyes. Besides the tactile organs spread over the whole surface of the body, the curiously shaped hairs of the palpi of *Ascorhynchus,* and perhaps of other genera, which probably are also organs of a special sense (olfactory?), the eyes are the only certainly known organs of sense in Pycnogonids.[2] In the first place, I tried to ascertain in how far the eyes can really be said to disappear in those animals which inhabit great depths. I therefore drew up the following list, in which the species from the "Challenger" and "Knight Errant" expeditions are placed according to the depths they inhabit.

[1] Hitherto I have studied only such sections of the ganglia as are made by cutting the whole body. These are sufficient for researches on the general anatomy, but totally insufficient with regard to histology. The numerous sheets and strips of connective tissue prevent the substance used for enclosing the body (paraffine or Calberla's substance) from penetrating the whole interior of the body. Thus some parts always remain disunited, and the cutting of thin sections is extremely difficult, if not impossible.

[2] The curious organ which Dohrn observed between the two eyes on each side of the oculiferous tubercle I have not observed. Perhaps it does not occur in *Nymphon,* the only genus in which I investigated the eyes.

Name of Species.	Depth in Fathoms.	Number of Eyes.	Condition of the Eyes.	Observations.
Discoarachne brevipes, Hoek,	...	Four.	Small; placed on a blunt tubercle.	
Hannonia typica, Hoek,	...	"	Small; placed on a rounded tubercle.	
Phoxichilidium fluminense, Kröyer,	7–20	"	Two anterior a little larger than the two posterior.	
Phoxichilidium insigne, Hoek,	7–20	"	Size of the eyes different, as in the foregoing.	
Nymphon brachyrhynchus, Hoek,	10–120	"	Large; oculiferous tubercle pointed.	
Nymphon brevicaudatum, Miers,	25–125	"	Small; oculiferous tubercle extremely elevated.	
Nymphon fuscum, Hoek,	25	"	Small; touching one another at the tip of a not very prominent tubercle.	
Ascorhynchus minutus, Hoek,	38	...	...	A blunt oculiferous tubercle, without eyes or pigment.
Pallene languida, Hoek,	38	Four.	Small; oculiferous tubercle not very prominent.	
Pallene lævis, Hoek,	38–40	"	Middle-sized; tubercle blunt and low.	
Pallene australiensis, Hoek,	38–120	"	Middle-sized; tubercle acute.	
Phoxichilidium patagonicum, Hoek,	45–120	"	Two anterior large, the two posterior much smaller. Tubercle high, but blunt.	Form of the tubercle differs with age.
Pycnogonum litorale, Ström,	53	"	Extremely small; tubercle blunt.	
Colossendeis megalonyx, Hoek,	55–120	"	Two anterior a little larger than the two posterior. Tubercle elevated.	Form of the tubercle differs with age.
Nymphon grossipes, Oth. Fabr., sp.,	83–540	"	Large; placed at the base of a high and acute oculiferous tubercle.	
Nymphon brevicollum, Hoek,	83	"	Large; oculiferous tubercle low.	Oculiferous tubercle obliquely truncated.
Colossendeis robusta, Hoek,	120	"	Two anterior large, two posterior small; oculiferous tubercle elevated and acute.	
Ascorhynchus orthorhynchus, Hoek,	150	"	Middle-sized, with pigment; oculiferous tubercle acutely pointed.	
Nymphon robustum, Bell,	375–540	...	No lens, and no pigment.	
Colossendeis leptorhynchus, Hoek,	400–1600	...	Two small spots (rudimentary lenses?) at both sides of the blunt tubercle.	Younger specimens with a more elevated tubercle.
Nymphon strömii, Kröyer,	515–540	Four.	Two larger ones directed forward, two smaller ones backward. Tubercle blunt.	
Nymphon mucronyx, G. O. Sars,	540	"	Not very large; tubercle bifid at the extremity.	
Colossendeis proboscidea, Sab. (sp.),	540	...	Two small spots (rudimentary lenses?) on both sides of the oculiferous tubercle.	Tubercle of the younger specimens elevated.
Phoxichilidium patagonicum, var. *elegans*,	600	Four.	Two large eyes directed forward, two smaller ones directed backward. Tubercle high, acute.	
Oorhynchus aucklandiæ, Hoek,	700	"	Small, with pigment; tubercle directed forwards.	
Nymphon perlucidum, Hoek,	825	...	...	Oculiferous tubercle low, without pigment.
Nymphon longicoxa, Hoek,	1100	Four.	Small; the pigment light-brownish; tubercle low and blunt.	
Nymphon compactum, Hoek,	1100	...	...	Oculiferous tubercle represented by a round spot.
Colossendeis minuta, Hoek,	1250	...	...	Two small rudimentary spots, without pigment; tubercle blunt.
Ascorhynchus glaber, Hoek,	1375	...	...	Oculiferous tubercle elevated.

Name of Species.	Depth in Fathoms.	Number. of Eyes.	Condition of the Eyes.	Observations.
Nymphon hamatum, Hoek, . .	1375–1600	...	...	Oculiferous tubercle also rudimentary.
Colossendeis gigas, Hoek, . . .	1375–1600	...	...	Oculiferous tubercle of the younger specimens higher, and furnished with two rudimentary spots.
Colossendeis gracilis, Hoek, . .	1375–1600	...	...	Oculiferous tubercle much elevated, with four lenses.
Phoxichilidium pilosum, Hoek, .	1600–1950	Four.	Two large ones directed forward, two very small ones backward; tubercle elevated and acute.	
Nymphon meridionale, Hoek, . .	1675	„	Distinctly pigmented; tubercle not very high.	
Phoxichilidium oscitans, Hoek, .	1675	„	Two very large ones and two small ones.	
Phoxichilidium mollissimum, Hoek,	1875	„	Two extremely large ones, kidney-shaped, directed forward; two very small ones directed backward.	
Nymphon procerum, Hoek, . .	2160	...	...	Two small spots are present on the tip of a low tubercle.
Nymphon longicollum, Hoek, . .	2225	...	...	Oculiferous tubercle high, with two rudimentary spots without pigment.
Colossendeis media, Hoek, . .	2225	...	...	Oculiferous tubercle very high and acute.
Colossendeis brevipes, Hoek, . .	2650	...	...	Oculiferous tubercle high and acutely pointed.

What we learn from this list is that it is a common feature for the shallow-water species to have four distinct eyes; and for those inhabiting a depth exceeding 400 fathoms to have no eyes, or to have rudimentary eyes without pigment. While exceptions to this rule are rare in the shallow-water species, they are by no means unfrequent in the deep-sea species. As to the structure of those eyes which may be called rudimentary, they often have a distinct lens—a rounded spot marked by its brightness; they are quite destitute of pigment, and, as I learned from a section of the oculiferous tubercle of *Nymphon robustum*, Bell, the small eye has no retina, and is filled up with a mass of detached connective tissue.

In those species which are furnished with distinct eyes, the size of those on the same tubercle is not always the same. In *Nymphon strömii*, Kröyer, the eyes which are directed forwards are slightly larger than those which are directed backwards, but this difference is much more marked in the species of *Phoxichilidium.* This difference in size —as is generally known—is a common occurrence. Grenacher[1] has shown in the simple eyes of the Arachnida and also of the larvæ of many insects, that this difference in size is often accompanied by extremely interesting differences in the minute structure. It

[1] Grenacher, H.—Untersuchungen über das Sehorgan der Arthropoden, 4o, Göttingen, 1879.

would be of interest to study this question in the Pycnogonida, but the limited number of the specimens of the different species of *Phoxichilidium* in the Challenger collection did not allow me to study their eyes. I investigated those of *Nymphon strömii*, but there the difference in size is slight; I did not ascertain any difference in their structure.

The knowledge of the minute structure of the eyes of the Pycnogonids is of very recent date. They were always considered as simple eyes, and were even mentioned as such by Cavanna. Dohrn, therefore, in the preliminary publication on the results of his studies on Pycnogonids, is the first who gives us some information on these organs. According to him the eyes, taken in a vertical position, are of a pointed oval shape;[1] they have a retina composed of modified epithelium cells (hypodermic cells), the extremities of which are surrounded by a brown pigment; the cuticula forms a lens.

Among the latest investigations into the structure of the eyes of the Arthropoda, those of Grenacher, published in his splendid memoir,[2] have the merit in the first place not only in proposing a homology between the parts composing a compound and those composing a simple eye, but also in showing the existence of this homology throughout almost the whole type of the Arthropods. Moreover, the value of his monograph with regard to the physiology of the organ of sight, and the immense quantity of special information which it contains, is at present almost inestimable. In investigating the eyes of the Pycnogonids, I was extremely desirous to try whether the scheme for the eye of the Arthropods, as proposed by him, would hold good also in the case of the Pycnogonids. Though my researches did not give me a complete idea of the anatomy of their eyes, I think my results are worth publishing here, because they admit of comparison with the scheme given by Grenacher.[3]

I made numerous preparations of the eyes of different species of the genus *Nymphon*; of *N. brevicaudatum*, Miers, *N. brachyrhynchus*, Hoek, *N. strömii*, Kröyer, and of the rudimentary eyes of *Nymphon robustum*, Bell. I studied more especially those I made of *Nymphon brachyrhynchus* and of *Nymphon strömii*. While the eyes of *Nymphon strömii* (Pl. XVIII. fig. 11, B) are comparatively small, and placed on the sides of a conical tubercle, so as to be separated by a greater distance from one another below than above; those of *Nymphon brachyrhynchus* are larger, and are placed on the inside of a cylindrical oculiferous tubercle, so close to one another as to meet at their inner surfaces. In fig. 2,

[1] Von oben nach unten spitz oval (*loc. cit.*, p. 37).

[2] Grenacher, H.—Untersuchungen uber das Sehorgan der Arthropoden, 4°, Göttingen, 1879.

[3] For studying the histology of the Arthropod's eye fresh material, in the first place, is necessary. That I got preparations fit to be used of the eyes of *Nymphon brachyrhynchus*, collected at Kerguelen Island, and put in spirits in January 1874, is almost more than could be expected. In one respect only did the condition of the material hinder me, viz., that I could not make use of some reagents, *e.g.*, of nitric acid. Though used of different strengths, I never obtained the solution of the pigment without the visual rods being destroyed also. Consequently I never got a preparation showing the connection between the fibres of the optic nerve and these rods.

Plate XXI., I figure a longitudinal section of one of the eyes of this species; and in the same figure the place occupied by the outer surface of the eye of the other side is indicated (*a*). This outer surface is invested by a thin chitinous cuticle, which is minutely (longitudinally) striped; round the circumference it is in connection with the chitinous skin of the animal. The inside of this wall is covered with pigment, and it is in this bed of pigment that the union of the fibres of the optic nerve with the elements of the retina takes place. I have already spoken above about the manner in which the optic nerve penetrates the eye. I sometimes got preparations, which made me believe that the optic nerve reached the outer integument of the oculiferous tubercle, at a considerable distance below the eyes, and that it ran along this wall and penetrated the eye where it is in connection with this integument; this, however, is not really the case. Numerous separate nerve fibres reach the under surface of the eye; they then penetrate its cuticle, and in one of my preparations I observed distinctly, that they are in direct connection with the rods of the retina.

In the interior of the eye there is a retina, but there is no distinct vitreous body. I observed that under the thickened cuticula which forms the lens of the eye, just as everywhere else, the epithelium (hypodermis) of the cuticula is formed of rudimentary cells represented by nuclei. Of a distinct row of vitreous body cells, like those figured and described by Grenacher (*loc. cit.*) and Graber,[1] I observed nothing. Nor do I believe that Dohrn's assertion is right, that in the eyes of the Pycnogonida the retina is derived from the epithelium cells (hypodermic cells). This retina consists of rod-forming elements and of ganglion cells. Those parts of the rods which are directed towards the fibres of the optic nerve are thicker and terminate abruptly (Pl. XXI. fig. 4), bearing at the other extremity a long and filamentary appendage; while in other preparations the retina elements which I isolated show the form figured in Plate XXI. fig. 5,—viz., rods which imperceptibly pass into thread-like appendages. In these retinal elements I failed to observe any trace of the presence of nuclei. The thread-like appendages of the rods extend till they reach the cuticular lens. A præretinal lamella, which, according to Graber, is characteristic of the stemma of the tracheate Arthropods is not visible. Between the rod-forming elements numerous ganglion cells are observed in the form of distinct rounded cells. I did not observe whether or not they were really in connection with the filamentary appendages of the rods; but having isolated from one of the preparations the rods, as figured in fig. 5, I found that the rod passes into the filamentary appendage. Probably the ganglion cells have also filamentary appendages, which pass between the filaments of the rods. In this respect therefore my opinion is intermediate to those of Grenacher and Graber. This structure is observed when the section passes vertically through about the middle of the eye

[1] Graber, V.—Ueber das unicorneale Tracheaten-und speciell das Arachnoideen-und Myriopoden-Auge. Archiv. f. Mikr. Anatomie. XVII. 1880, p. 58–93, Pl. v.–vii.

(Pl. XXI. fig. 3). When the same (tangential) section passes through the lateral part of the eye another structure is observed (Pl. XXI. fig. 2), viz., a mass of reticular tissue, with numerous ganglion cells in its meshes, not unlike but a little smaller than those between the rods of the retina. Empty cavities, from which, perhaps, ganglion cells have dropped, are observed in it. A horizontal section of one of the eyes of *Nymphon strömii* (Pl. XXI. fig. 1) shows the arrangement of these parts in the interior of the eye. The middle part is that occupied by the retinal rods, which here have large ganglion cells at their extremities, and a distinct mass of reticular tissue, separated from the retinal rods by a thin membrane (?), is observed laterally. The dimensions of the ganglion cells placed in the meshes of this reticular tissue in *Nymphon brachyrhynchus* are almost the same as those observed between the retinal rods; but in *Nymphon strömii* the ganglion cells which are found at the extremities of the retinal rods are much larger. In regard to the minute structure of these ganglion cells I have hardly any observations worthy of being mentioned. The cells are always furnished with a distinct nucleus, and their contents, as a rule, are granular. Those I observed between the rods of *Nymphon brachyrhynchus* are furnished with one filament directed towards the lens.

The conclusions I have arrived at with regard to the anatomy of the organs of vision in the Challenger Pycnogonids may be summarised as follows:—

(1.) A vitreous body, developed out of the cuticular epithelium (hypodermis), does not exist.

(2.) The epithelium cells are present under the lens of the eyes in the same condition as under the cuticula in general.

(3.) The retina consists of distinct rods and ganglion cells. Numerous ganglion cells, placed in the meshes of a reticular tissue, form a mass, which encloses the interior of the eye occupied by the rods.

(4.) The ends of the retinal rods reach the cuticular lens. A præretinal interlamella seems not to exist.

(5.) The retinal rods can not be considered as having resulted from transformed hypodermic cells.

(6.) The retinal rods have two parts—an innermost thicker part and a filamentary appendage.

(7.) The eye is surrounded by a chitinous cuticula.

4. *Alimentary Canal and its Appendages.*—I only occasionally got preparations of the alimentary canal; therefore what I have observed in regard to this organ is far from exhaustive.

Physiologically, this is perhaps the most interesting organ of all, and, morphologically, its signification is by no means small, as its structure has, along with the number

of the legs, always been considered as a very important support for the belief in the near relationship between the Pycnogonida and the Arachnida, and more especially the Phalangida.

Morphologically, the œsophagus extends from the mouth to behind the œsophageal commissures. Taking the function of the organs into consideration, I believe that only an extremely small part should bear the name of œsophagus. At a very short distance from the mouth the œsophagus widens considerably. This widened part, which shows its greatest dilatation in front of the middle of the proboscis, slopes again backwards, and imperceptibly passes over into a much narrower canal, which extends immediately behind the œsophageal commissures. The widened part of the œsophagus, which almost reaches to the end of the proboscis, is invested by a chitinous wall. This wall is beautifully beset with thin parallel chitinous bands, which are furnished with numerous thin spines. In the front part these are wanting. They begin on the two ventral parts of the inside a little before they are found on the dorsal part. These foremost spines have the form of short teeth, and only further back do they assume the form of long thin spines or needles. From the wall of this part of the œsophagus numerous bundles of transversely striated muscles extend till they reach the outer wall of the proboscis, their distribution being in *Nymphon*, *e.g.*, such that two longitudinal rows are attached to each of the three parts of which the inner wall of the œsophagus is composed (Pl. XVIII. fig. 9). As to the function of this part of the œsophagus, judging from these muscles and from its internal armature, I think it not very hazardous to compare it with the cardiac portion of the stomach of the Crayfish. It is a masticating apparatus.

Posteriorly it passes over into a very long (slender species of *Nymphon*), or rather short (*Colossendeis*) cylindrical tube, the wall of which is still divided into three longitudinal parts, which on a transverse section are triangular and leave an extremely narrow canal in their middle. I studied the histological structure of this part of the wall, which extends to beyond the œsophageal commissures. Its cells are of a long cylindrical form, longer in the middle and shorter on both sides of the triangular part. They are furnished with distinct nuclei, which sometimes are all placed near the outwardly directed extremity of these cells, but sometimes also are found more in the middle. Between these cylindrical cells there are some of a long conical shape, the base of the cones being, as a rule, directed outwards. Inside, the surface of these cells is invested by a structureless membrana intima, and outside a similar cuticular formation is present (Pl. XXI. fig. 6). This epithelial covering does not end abruptly immediately behind the œsophageal commissures. In the interior of the succeeding part of the intestine it forms three glandular bodies, which hitherto have not been observed, and whose function, judging from their position, must be, I believe, pancreatic. In fig. 7 on Plate XXI. I show the place occupied by these glands, and in fig. 8 of the same plate a transverse section near the extremity of the two

undermost glands is figured. These glands project into the interior of the intestine, and are, as far as I know, the only true glandular bodies which stand in connection with the alimentary canal. They are invested by the same membrana intima as the wall of that part of the œsophagus, at the end of which they are found. The form of the cells which compose them is nearly the same. The whole of the gland must be considered as having taken its origin from an excrescence and bending towards the wall of the intestine, of the hinder part of that œsophagus.

In regard to the structure of the remaining part of the intestine I do not wish to enter into any details. I only observed that the structure of the wall of that part which follows immediately after the œsophagus, and of the cæca, which penetrate as a rule as far as the sixth joint of the leg, is nearly the same. We find this wall everywhere beset with extremely numerous tubes or villi, which in some genera (*Nymphon*) are of a shorter and more rounded form, and in others (*Colossendeis*) are very slender and almost cylindrical. While the outermost part of the wall is formed of a single row of large distinct nucleated cells, these villi show a multi-cellular structure also. Each of these cells contains numerous globules, which for the most part seem to be of a fatty nature. The form of the cells is different, but they are commonly rounded. I call them cells, because each of the bodies has a distinct oval nucleus with a small nucleolus. As has been observed by almost all authors writing on the structure of the wall of the intestine, these cells often become detached from the wall, and are found lying loose in the contents of the alimentary canal. The nuclei in the cells of these villi were by no means easily observed in all the sections I studied. They were very distinct in the cells of the villi of *Colossendeis proboscidea*, Sab. (sp.).

It seems to be characteristic of the genus *Colossendeis* that the cæca destined for the different legs should branch off from the main duct, which runs straight from the proboscis to the abdomen, very close to one another, and close also to the place where the œsophagus communicates with the intestine; at least I observed that in the three species of *Colossendeis* I studied (Pl. XVII. fig. 1). The number of lateral cæca given off at both sides of the main duct is six in *Colossendeis*. Of these the first two are rudimentary, one being the rudiment of those destined for the mandibles, the other (the first lateral pair) being that for the proboscis. Each of the four remaining cæca, of which the hindermost pass through a much longer part of the body before penetrating the leg than do the more anterior ones, shows a considerable swelling in the lateral processes, at the ends of which the legs are inserted.[1] The anal aperture of *Colossendeis* (Pl. XVII. fig. 1*d*) is an oval-shaped slit. It is not placed terminally or in the median line of the abdomen, but laterally.

[1] On a transverse section of the body of a *Colossendeis* between the lateral processes for the second and for the third pair of legs, five round sections of the intestine are seen placed close to one another. This furnishes a good opportunity of comparing their structure, but no difference is observed. Compare fig. 14 of Plate XXI.

In *Nymphon* the number of lateral cæca of the alimentary canal is five pairs. Of these the first pair is very wide and directed forwards. At the base of the proboscis it divides into two branches. One (the larger one) is directed upwards and forwards, and penetrates the mandibles; the other one enters the proboscis and divides, in some species (*Nymphon brachyrhynchus, e.g.*), again into two branches. These extend in some species farther than in others, but I never observed them beyond the hindermost half of its length.[1]

The groups of comparatively large cells with very thin walls and distinct nuclei, each of them containing, as a rule, one (sometimes more) strongly refracting granule probably have also some relation to nutritive functions. These I observed in *Nymphon*, *Phoxichilidium pilosum*, and in *Colossendeis*, collected in large groups sometimes about fifty in number. They seem not to be limited to any particular part of the body, but I found them always in the neighbourhood of the muscles, between the connective tissue, where fibrous threads keep them in place. I feel inclined to consider them as analogous to the fat-cells of most Arthropods. I figure a group of them in Pl. XXI. fig. 9.

5. *The Circulatory Apparatus.*—The somatic cavity is divided into distinct compartments, by means of sheets and bands of fibrous tissue. One of these, placed between the dorsal wall of the intestine and the dorsal integument of the body, is furnished with contractile walls, and has the function and the structure of a heart. In *Colossendeis* this heart is not surrounded by a pericardial sinus (Pl. XXI. fig. 14, *h*, Pl. XVII. fig. 1). The blood, entering the apertures of the heart, comes directly from one of the longitudinal compartments into which the somatic cavity is divided. The contractile walls of the heart do not enclose it on all sides; for on the dorsal side a part of the integument is used to form the dorsal wall of the heart. The contractility of these walls is due to the presence of muscles, which run in a transverse direction and are not striated. Along both sides of the heart these muscles are inserted into the dorsal integument of the body. As to their structure, I observed their fibres to be extremely thin and slender. When studying them with a strong lens (*e.g.*, **11**, Immersion of Hartnack) I observed that they exhibit parallel edges only for a certain distance; for this parallelism almost imperceptibly passes over into an extremely feeble swelling of the fibre, in the interior of which a long nucleus with a distinct nucleolus is observed.

The heart of the Pycnogonids, as a rule,[2] is furnished with three pairs of apertures.

[1] In one specimen of *Nymphon brachyrhynchus* I observed that one of the branches penetrating the proboscis divided again, so that in the same section, through about the middle of the proboscis, five sections of intestinal cæca were observed. This I consider of no importance at all. It only proves, I believe, that it is almost dangerous to attribute any fundamental value to the number of pairs of cæca arising from the intestine. In a large specimen of *Pycnogonum litorale* a section of the fourth joint of the leg shows two sections of cæca in the same joint: the cæcum has given off a branch. Consequently I believe that the number of these branches depends in general upon the capacity of the different appendages. In *Nymphon* and *Colossendeis* no cæca are observed entering the palpi and the ovigerous legs, only because the capacity of these extremities does not allow of it.

[2] Not always. *Pallene brevirostris*, Johnston, *e.g.*, has only two of these.

The first pair are placed on the sides of the heart opposite to the second pair of legs; the second pair are placed similarly, but opposite to the third pair of legs; the third pair are found near one another at the posterior extremity of the heart. Through these three pairs the blood is admitted into the heart,[1] while it leaves it through a large opening placed at its anterior extremity. No aorta or arteries arise from it. In the heart of the specimens in spirits of *Nymphon robustum* and some other species I observed a compact mass of blood-plasm, which so totally filled up the cavity of the heart as to give, after having been taken out, an exact figure of its form.

As to the blood-corpuscles I only observed that they are, in *Nymphon* and *Colossendeis*, round and flat bodies with a distinct nucleus. However, I observed also more irregularly-shaped fusiform bodies, especially numerous in the cavities of the skin of *Colossendeis* (Pl. XVIII. fig. 1). With regard to their shape and dimensions there is no great conformity between the opinions of Cavanna and Dohrn; however, it is only the study of fresh material that can finally settle such controversies.[2]

6. *Genital Organs.*—About the testis of the Pycnogonids hardly anything is known; and this cannot be wondered at when one considers that the true males were only discovered by Cavanna in the year 1875, the animals with swollen thighs described as males before that period being really the females. However, even Cavanna does not seem to have correctly identified the male organs, for he places them in the fourth joint of the legs. Dohrn has been the first, and hitherto the only one, who has pointed out the true position occupied by the testis, "Die Hoden liegen im Körper der Pycnogoniden, nicht in den Beinen, und bilden dort jederseits einen Schlauch, welcher in jede Extremität seiner Seite einen kleineren Schlauch absendet, der an der obenerwähnten Stelle in einer runden Oeffnung endet." This description, true in the main, is, however, not applicable to all the species of Pycnogonids; for, from what I have observed myself, I am able to furnish full evidence that, for some species, Dohrn's description is not quite correct.

A large specimen of a male *Colossendeis proboscidea*, figured of the natural size in Plate XXI. fig. 10, has been opened on the dorsal side. The skin with the heart being removed, the testis is observed *in situ*, and the intestine may be distinguished below it; the male organ, therefore, is placed rather at the dorsal side of the body.

The two laterally and longitudinally running parts of the organ are united posteriorly

[1] From observations I made, in the summer of 1880, in the laboratory of Prof. Lacaze-Duthiers at Roscoff.

[2] Cavanna calls them "piccolissimi globuli ellitici o sobellittici." Dohrn, on the other hand, describes the blood-corpuscles as "ungewöhnlich gross und complicirt." According to Dohrn, there are two forms of blood-corpuscles—"die einen bilden einen blassen, suzammengefalteten Ballon, in dem ein etwas glänzenderer linsenförmiger Kern sich findet neben 3–4 grossen Vacuolen; die anderen sind deutliche Amöben, mit lebhaften amöboiden Bewegungen und umschliessen oder tragen eine grössere Anzahl glänzender Tröpfchen." It seems to me that the large balloon-forming elements come very near to my fat cells (see p. 127); and as to the amœboid corpuscles, these are probably my fusiform elements and the elliptic ones of Cavanna. If Dohrn is right about his large blood elements, then the animals must have still others of a third form.

by a commissure, so there is only one true testis, which has the form of a capital U. From the upstrokes of this U, on both sides, those parts originate which penetrate the leg, and which extend almost to the end of the fourth joint. The two parts of the testis which run longitudinally through the body are broad and flat; their course is not straight but rather undulated, being bent outwards whenever a lateral branch takes its origin. Although the organ is placed at the dorsal side of the body and legs, the male genital pores are situated ventrally towards the end of the second joint of each leg. This external opening is very small and is at the tip of a distinct conical tubercle. It leads into a canal which runs backwards almost parallel with the margin at the distal extremity of the joint and closely adheres to its chitinous covering; this canal runs along the wall of the joint till it reaches the dorsal side of the leg, here it becomes wider and turns inwards till it reaches the testis, which shows a small knob facing the beginning of the canal. Plate XXI. fig. 11, shows these particulars; the joint is figured as transparent, and the muscles which run from this to the following joint are to be considered as removed. The outer part of the canal, from the opening for about one-fourth of its length, is furnished with a thicker wall, and this shows most probably the extent to which the chitinous covering of the leg is bent inward. The remainder of the canal is formed of connective tissue,—at least I failed to observe an endothelial covering,—lined externally by a distinct muscular layer, the fibres of which run longitudinally and are not striated (Pl. XXI. fig. 13).

As seen in fig. 2, Plate XVIII., that part of the testis which penetrates the leg is in a transverse section kidney-shaped; a longitudinal duct is formed between the gland and the thin tissue or membrane which it touches laterally at two points. Most probably it is with the duct so formed that the canal which opens at the distal extremity of the second joint is in communication.

I have observed nearly the same structure of the male genital organs in the extremely transparent species of *Nymphon*, to which I have given the name of *Nymphon perlucidum* (p. 50 of this paper), and also in *Nymphon robustum*, Bell. Both species show genital pores in the male sex, only on the two hindmost legs; and quite in correspondence with this observation only two pairs of lateral excrescences of the U-shaped testis are to be seen. So when Dohrn says, for Pycnogonids in general, that the male organs penetrate each leg and open in a round pore on the ventral side (which is, no doubt, the case in all the species examined by him), he is laying down a rule which admits of a great many exceptions; for among the Pycnogonids dredged by H.M.S. Challenger there are species having their male genital pores only on the two hindmost legs; again, there are some which possess them on the three hindmost pair of legs, and, finally, there are species with pores on all the legs. My doubts about this point were cleared up by the observation of those species which bear their male genital pores at the tip of a stout cylindrical outgrowth (species of *Ammothea*, *e.g.*).

Of course the non-existence of a hardly distinguishable structure cannot be considered proved merely because the structure has not been observed, even in numerous specimens of the same species. But, on the other hand, if the structure is very easily seen in some specimens, we are at liberty to conclude that it is absent in those cases where it was not observed. Moreover, it is hardly possible that in those cases where the pores are only observed on the two hindmost legs, they should be present also on the foremost, and from some unknown circumstance should continually escape observation.[1]

In regard to the microscopical structure of the testis I have not much to say. On a transverse section numerous extremely minute cells are observed (see Pl. XXI. fig. 12), while that part of the testis which adjoins the longitudinal canal has lost its cellular structure, and shows a rather granular condition. Whether these granules are the spermatozoa, or whether the numerous globular bodies each furnished with a filamentary appendage on one side which I once observed, when pulling to pieces with needles a part of the testis, are the spermatozoa, cannot, of course, be ascertained from animals in alcohol, even when preserved so well as the Challenger specimens are. Only in mature animals do the male organs attain the development figured for *Colossendeis proboscidea.* This, most probably, is only the case during a short period of the year, considering moreover that the males in most species seem to be less numerous than the females (ten female *Colossendeis proboscidea* and only one male, twelve female *Colossendeis leptorhynchus*, and only one male, &c.), it cannot be wondered at that the number of species in which I could investigate these organs was limited. Except in *Colossendeis proboscidea*, and in three species of *Nymphon*, I observed the testis also in the leg of *Ascorhynchus glaber* (Pl. XVI. fig. 9, *n*), but here only in the fourth joint of the leg.

In the other specimens which I consider as males, the only means I had to make out the sex consisted in looking for external sexual characteristics, such as are afforded by the dimensions of the genital pores and the condition of the thighs. Large genital pores and swollen thighs are characteristic of the females; slender thighs and small pores, very often not present in the first or in the first two pairs of legs, are characteristic of the males. Moreover, a transverse section of the thigh of one of the legs is easily made, and does no injury worth mentioning to the specimen. When in such a section no ovary is observed, so far as my experience goes, it is almost certain that the

[1] The genital pores of *Nymphon robustum*, Bell, ♂, are tolerably large, and are easily observed with the aid of a magnifying glass. Yet I have examined large specimens of this species (dredged in the Barents Sea), where these pores were not observed, even when investigating the joints with the microscope. As I was convinced of the exactness of this observation, I felt greatly puzzled with it at first; afterwards on reading a paper of Schöbl in the Archiv f. Mikroskop. Anatomie, Bd. xvii., 1880 (Ueber die Fortpflanzung isopoder Crustaceen) I found that this author admits that in the females of these Crustaceans, the genital pores are only present at a certain period, and are totally wanting during the rest of the year. Perhaps there are male Pycnogonids which have the same peculiarity.

specimen is a male; even in very young females at least a trace of the ovary is always to be observed in those joints.

According to Dohrn the female glands are disposed in the same way as the testis, with the only difference, that in the ovaries of most species, the lateral excrescences which penetrate the legs and often force their way into the penultimate joint, are the only parts which develop mature eggs.

What I happened to observe agrees almost completely with Dohrn's description. I perfectly believe, however, that the occurrence of a part of the ovary in the body of a Pycnogonid is rather rare, because, as a rule, only the lateral excrescences remain. No doubt this must be considered as a secondary condition; and seeing that, so far as I could ascertain, it is the rule in all the species of *Nymphon*, my original opinion, that the genus *Nymphon*, of all the genera of Pycnogonida, resembled most the hypothetical ancestors of our group, was severely shaken.

The genus *Colossendeis* affords a beautiful example of the original condition of the ovary. I examined a specimen of *Colossendeis leptorhynchus*, Hoek. A transverse section of the body showed the place occupied by the ovary, and convinced me of the exactness of Dohrn's assertion. However, as in the case of the testis, Dohrn's observation is incomplete in one respect; there are not two ovaries, but only one. Immediately in front of the abdomen the two lateral parts are united by a cross-piece, and so the ovary has the very same shape as the testis, viz., that of a U with long upstrokes. That it occupies also the same position in the body as is the case with the testis, is clearly seen in fig. 14, Plate XXI., which is a drawing of a transverse section of the body. In *o.* the ovary is shown placed above the intestinal tract and its excrescences which penetrate the legs. The dimensions of the eggs in that part of the ovary which is situated in the body are, at least in this species, the same as of those eggs which are found in the thighs of the legs. The lateral excrescences penetrate all the legs, and in the specimen I studied reach the sixth joint. This, most probably, will greatly depend on the state of maturity of the animal. I often found the eggs only in the thigh, but often also (*Hannonia typica*, Hoek, Pl. XIV. fig. 11, *e.g.*) the eggs are found as far as the end of the second tibial joint. The ovary is always placed dorsally to the intestinal tract, which is also the case with those animals which have only the lateral excrescences left, and thus show several ovaries.

The structure and the formation of the ovarian eggs I will describe further on. In regard to the way in which the eggs are laid, I had the good fortune to observe the copulation of a male and female *Phoxichilus laevis*, Grube, when I was, last summer, in the zoological station of Professor H. de Lacaze-Duthiers at Roscoff. The eggs are fecundated the moment they are laid, and the copulation, therefore, is quite external, brought about by the genital openings of the two sexes being placed against each other. Half an hour after the beginning of copulation, the male had a large

white egg-mass on one of his ovigerous legs, and about one hour later both masses were present.

The female genital openings are a great deal larger than those of the male, and are of an ovate shape, and, as a rule, oviducts are totally wanting. I only observed them in the genus *Colossendeis*, where they have nearly the same course as the vasa deferentia. Nearly in the middle of the second coxal joint of the two hind legs a lateral branch arises from the ovarian cœcum, which passes through the joint. The interior of this branch, which is the oviduct, is in immediate communication with the ovary, and during the breeding season the eggs are found penetrating the branch. While the ovarian cœca which penetrate the legs are lined only by connective tissue, the oviducts which begin at the dorsal side of the second coxal joint and run along the wall of the joint till they reach the opening on the ventral side, are lined by a coat of longitudinal muscle fibres. The female genital opening in this species is small and rather triangular.[1]

From the end of the oviduct which reaches the opening, distinct muscle fibres radiate, and are inserted round the opening on the inside of the chitinous wall of the joint. A transverse section of the fourth joint of the leg of a female *Colossendeis leptorhynchus* is figured in fig. 16, Plate XVI.; *m* is the ovarian cœcum which, as this specimen is by no means mature, is only of small dimensions; when in the breeding season, the whole central cavity (which in the figure is represented as empty) is filled with eggs; it swells to such an extent as to fill up almost the whole cavity of the leg, in so far as this is not occupied by the intestinal cœcum. As in the other species of *Colossendeis*, the eggs are extremely numerous and small. Each ovarian egg has a distinct germinal vesicle, which is placed almost exactly in the centre of the egg, and has, as a rule, one distinct and very glittering germinal spot. Among the older eggs, which are richly furnished with yelk, smaller ones are always observed whose protoplasm is almost quite transparent. Each egg is surrounded by a very thin membrane, which is a true "vitelline membrane" and adheres closely to the protoplasm of the egg.

In the genus *Nymphon*, I have investigated the female genital organs of the following species:—*Nymphon brevicaudatum*, Miers; *N. brachyrhynchus*, Hoek; *N. robustum*, Bell; *N. longicoxa*, Hoek; and *N. hamatum*, Hoek. I never observed the ovary in the body of these species, and always found at least a trace of it in the fourth joint of the leg (thigh).

When in an early stage of development, the ovary is placed against and at the dorsal side of the intestinal cœcum which passes through the joint. While the ripe ova, which are often very large (Pl. XVI. fig. 7 *l*, ripe ovum of *Nymphon brevicaudatum*, Miers), have a thin vitelline membrane as in the ovum of *Colossendeis*; younger ova have often the

[1] In this species, as I have mentioned already (p. 63), the genital openings, both in males and females, are present only on the two hind legs; at least in all the specimens at my disposition, I failed to observe them on the first two pairs of legs. However, ovarian cœca penetrate the first two pairs of legs as well as the two others.

appearance of being surrounded by a very thick and concentrically stratified membrane (ovarian egg of *Nymphon brevicaudatum*, Pl. XXI. fig. 15). In other species (*Nymphon robustum*, Pl. XXI. fig. 16) this membrane is perfectly transparent, while in both cases the granular protoplasm of the egg within this thick membrane or capsule seems to be surrounded by its vitelline membrane. In a third case, which I observed in *Nymphon longicoxa* (Pl. XXI. fig. 17), the membrane of the egg does not seem to be thick, but irregularly folded and crumpled; yelk-particles are here very numerous in the central part of the egg, which surrounds the germinal vesicle; and the protoplasm of the egg extends beyond this central part till it reaches the crumpled membrane. However, it is very probable that the condition of the eggs has suffered from their having been so long in alcohol, only I wish to point out that from what I observed it is almost certain that any one studying the formation and the development of the animal egg, will find a very interesting object in the egg of the Pycnogonida. The dimensions of the mature ova are very different. Of the specimens I studied they are largest in *Nymphon longicoxa*, *N. brevicaudatum*, and *N. robustum*, a great deal smaller in *N. brachyrhynchus* and *N. hamatum* (the number of eggs united in an egg-mass being always in inverse proportion to their size).

While in the younger ovarian eggs the germinal vesicles as a rule are placed in the centre of the egg, in the very large mature egg the vesicle is placed close to the wall. Sometimes (*Nymphon longicoxa*) it has the shape of a sand-glass, and once I observed an extremely small micropyle canal in the membrane of the egg, just opposite the place occupied by the germinal vesicle. As a rule there is only one germinal spot, but I once observed two distinct spots in the germinal vesicle of the egg of *Nymphon longicoxa*. In the ovarian egg of *Nymphon robustum* one distinct nucleolus may be observed almost exactly in the centre of the rounded and granular germinal spot. As for the manner in which the eggs make their way to the genital apertures in those cases in which no true oviduct is observed, I think there can be no doubt that the body-cavity itself performs the function of an oviduct. The absence of such a duct at the genital pores, and the fact that I repeatedly observed detached eggs pressed against the connective tissue surrounding the ventral ganglia or other parts in the interior of the body admits of no doubt in this respect.

All I have said about the ovary and the formation of the ova in the genus *Nymphon* also holds good in the case of the other genera. The limited quantity of specimens prevented me from making a section of the body of species of these genera. Most probably *Ascorchynchus* will show the same disposition as *Colossendeis*. A transverse section of the thigh of one of the legs of *Ascorchynchus orthorhynchus* is figured in Plate XVI. fig. 11. The thigh is much more dilated than one of the other joints of the leg, yet it is not round but flattened, and the contents are almost divided into two unequal parts by the large chitinous thickening, which at the one side is in connection

with the wall of the leg. The one part is filled up with the ovary, the other partly with the cœcum of the intestine. The ovarian eggs are small and are furnished with a central germinal vesicle. Most probably the females of the species of *Ascorhynchus* have an oviduct like that of the species of *Colossendeis.* The species of *Pallene* show the same disposition as in *Nymphon.* A transverse section of the thigh of *Pallene australiensis* corresponds perfectly with that of *Nymphon brevicaudatum,* figured in Plate XVI. fig. 7; there is one very large and probably mature egg with an eccentric germinal vesicle, and numerous smaller ovarian eggs, with their vesicle in the centre. Moreover, minute researches on *Pallene brevirostris* (an inhabitant of the Dutch coast) admit of no doubt as to the structure of the ovaries; they are totally wanting in the body, and take their origin in the thighs of the legs. The eggs when mature are large, and their number is limited.

In the genus *Phoxichilidium* I studied the anatomy of the body of *Phoxichilidium pilosum* (a female specimen) without meeting with the ovary. In the legs of this species, however, and also of *Phoxichilidium patagonicum,* I soon found it. The whole cavity of the leg is often filled up with eggs, and these are even observed pressed closely against the wall of the leg (Pl. XVI. fig. 17). The eggs are comparatively small and very numerous. The membrane of the eggs is much thicker than is the case with the eggs of the other genera (Pl. XXI. fig. 18). Neither in the species of *Pallene* nor of *Phoxichilidium* did I observe the least trace of an oviduct, so I think that here, as in *Nymphon,* the genital aperture communicates directly with the cavity of the leg. I think also that the circumstance I often observed of eggs free in the cavity of the leg is in support of this opinion (Pl. XXI. fig. 18). For the other genera of Pycnogonids I have, so far as the ovaries are concerned, no observations worth mentioning.

7. *Observations on the Embryology of the Pycnogonida.*—Among the Pycnogonids of the Challenger Expedition there were some species provided with eggs. On account of the great importance of embryology for the study of the affinities of a group of animals I tried to acquire as much information on this subject as possible. Unfortunately, with the exception of one species belonging to the genus *Ascorhynchus,* G. O. Sars, all the species with egg-masses belong to the genus *Nymphon,* Fabr., but of these there are out of twelve species no less than six provided with eggs.

The researches of Kröyer, Johnston, Goodsir, Dohrn, Semper, Cavanna, and myself, have shown that in the genera *Pycnogonum, Pallene, Phoxichilus, Phoxichilidium, Nymphon,* &c., the eggs after having been laid are carried on the so-called ovigerous legs. The honour of having discovered that not the females (as was believed by the older authors) but the males fulfil the duty of bearing these eggs is due to Cavanna; this observation has since been confirmed by the researches of Dohrn, Böhm, and myself.[1]

[1] The observations of Cavanna were published in the year 1875. It is indeed strange to see that neither Wilson nor Miers have heard of this discovery. These authors, in their descriptions of new species, &c., are therefore almost constantly confounding the two sexes.

In the first place, however, I wish to draw special attention to the fact that with regard to *Nymphon brevicaudatum*, Miers, this rule admits of an exception. I examined a species with large genital pores and swollen thighs, and provided with egg-masses on the ovigerous legs. On investigating transverse sections of the thighs, I soon saw that this specimen was a female. So far as I know, this is the first time that an exception to this rule has been observed. In the second place, I wish in a few words to discuss the circumstance that, although eight different species of the genus *Colossendeis* were collected (together represented by thirty-one specimens, and four specimens of *Colossendeis proboscidea*, Sab. (sp.), trawled north of Scotland during the cruise of the "Knight Errant"), none of these are provided with eggs. The number of males, however, is very restricted: there is only one male *Colossendeis leptorhynchus* among nine specimens, there is one male *Colossendeis gigas* among six specimens, one male *Colossendeis megalonyx* among seven, and, finally, one male *Colossendeis brevipes*. On the other hand it is possible that the genus *Colossendeis* is an exception to the rule, and that the males in this genus may not have the gallantry to nurse their babies as the males of the species of other genera are accustomed to do. For, comparing the ovigerous legs of the males with those of the females, a distinct difference is almost always easily observed: those of the males are a great deal stouter, the fifth joint is as a rule swollen towards the extremity, or furnished with a distinct knob, &c.; but in the ovigerous legs of the males of the species of *Colossendeis*, these differences in form and size are never observed. So it is quite possible that they deal differently with their eggs from the species of other genera.

The species provided with eggs are: *Nymphon hamatum*, Hoek; *N. longicoxa*, Hoek; *N. fuscum*, Hoek; *N. brevicollum*, Hoek; *N. brachyrhynchus*, Hoek; *N. brevicaudatum*, Miers; and *Ascorhynchus minutus*, Hoek. Of the latter species there are in all two specimens, and of these one bears eggs. But the development of these eggs is in its last stage, so that I was only able to ascertain the form of the larvæ. The eggs of this species are extremely small, and at the same time numerous.

It consequently happened that my embryological researches were limited to the genus *Nymphon*; in so far not unfavourable, as yet almost nothing has been published on the embryology of this genus.

Full-grown males of the genus *Nymphon* bear the eggs on the fourth and fifth joints of the ovigerous leg, or only on the fifth joint; the curious foliaceous appendages occur on the sixth to the tenth joints of the leg, and have nothing to do with the egg-bearing function of the leg. Yet it is possible that they may be of some use in seizing the eggs when just laid, but, on the other hand it must be observed, that in the genera where these appendages occur, the ovigerous legs of the females are furnished with them as well as those of the males.

The eggs are soldered together and form in the species of *Nymphon* I studied, and

in *Ascorhynchus minutus*, one packet only on each ovigerous leg. I believe, however, that cases are by no means rare in which two or even three packets are formed on one ovigerous leg. The packet is placed round the leg, and in some species (*Nymphon brachyrhynchus*, Hoek, *e.g.*, Pl. XIX. fig. 1), it may be easily brushed off. In other species, however, *Nymphon robustum*, Bell, for example, this is by no means so easy, the surface of the joints of the ovigerous legs being furnished with numerous hook-like spines.

Every egg in the packet has its own membrane, a very thin and structureless tunic. The size of the packets is very different. It varies greatly with the size of the animal, but is different also in different specimens of the same species. The size of the egg seems to be constant for every species ; consequently the size of the packet will depend on the number of eggs in each packet ; and the age and the condition of the female will, of course, influence this.

The egg of *Nymphon brevicaudatum*, Miers, measures 0·5 or 0·7 mm. ; when in the first stages of development it is nearly globular (0·6 × 0·6 mm.), afterwards oval (0·5 × 0·7 mm.). The number of eggs in each packet varies between fifty and sixty. The egg of *Nymphon fuscum* is a great deal smaller (0·15 or 0·12 mm. The eggs of *Nymphon brachyrhynchus* are about 0·55 mm. and even in a much advanced stage of development nearly globular. Large packets of the latter species do not contain more than fifty eggs, and the dimensions of these packets vary between 3·14 × 1·85 mm. and 2·3 × 1·6 mm. The egg of *Nymphon brevicollum* has a diameter of 0·26 mm.; the number of eggs in a packet is in this species about ninety. Fig. 2 on Plate XIX. gives a section of a packet of eggs of this species. The colours are those which are seen when the object is coloured with picrocarmine, and the figure is half in outline ; every egg is seen to be placed in a cavity formed by the cement which solders the eggs together (*c*), and coloured distinctly red by the picrocarmine. The large opening (*o*) in the centre is that occupied by the ovigerous leg ; the small holes (*s*, *s*) are those which are left between the eggs when soldered together. On the outside mud and sand particles adhere to the packet (*m*).

So far as I know, Dohrn is the only author who has published observations on the cleavage of the Pycnogonid egg ;[1] but as the method of making sections of such very small eggs was not yet in use when he published his paper, and could not, therefore, be applied by him, I might reasonably have expected to see much more than he did, by availing myself of this method of recent embryology. Yet my researches in this respect were not very successful, owing at least partly, I believe, to the condition of the material I studied. Every one will acknowledge how necessary it is, especially in embryological researches, to study fresh and also very rich material ; now the Challenger Pycnogonids had been six or seven years in alcohol before I studied their eggs, and, moreover, the

[1] A. Dohrn, Ueber Entwicklung und Bau der Pycnogoniden, Jenaische Zeitschrift, Bd. v., 1869.

quantity was limited, so I need not appeal to the indulgence of the reader on account of the imperfection of my researches in this department.

The study of the eggs of *Nymphon brevicaudatum*, Miers, was the most successful of all. These eggs are the largest of the species here in question; the number of animals furnished with eggs was in this species rather great;[1] and their condition was superior to that of the eggs of the other species. The method I followed is well known. I enclosed the eggs (hardened with absolute alcohol) in paraffine, and coloured the sections afterwards with picrocarmine.

Fig. 3 is a drawing of the first stage I was able to observe. The food-yolk and the formative-yolk (deuto- and proto-plasma, Ed. van Beneden) are still mixed together, and the cleavage is complete. Every segment is furnished with a nucleus, coloured distinctly red by the picrocarmine, and situated almost in the middle of each segment. The structure of the yolk particles in each segment is very curious, and probably this is caused by the continued action of the alcohol. In fig. 4 I give a strongly-magnified drawing of a small part of such a segment just at the border of the section. It looks as if the yolk-elements had grown vesicular,—a matter I only make mention of as the same structure is no longer observed in the next stage of development of the egg. In this stage, as in the following, the egg is furnished with a distinct but very thin membrane.[2]

The second stage I observed has the blastoderm distinctly developed. The cells of which it is composed are very much flattened, and do not show distinct limits; a very large nucleus is, on the contrary, always easily observed. Fig. 5 shows the cells as seen on section, fig. 6, the blastoderm with the nuclei magnified. Every nucleus shows a distinct nucleolus and numerous small granules. In this stage the food-yolk is irregularly split into larger or smaller parts, which are coloured yellow by the picrocarmine; they do not show the vesicular structure of the yolk-segments in the first stage, and are not furnished with a nucleus.

A transverse section of the next stage of development I observed is figured in fig. 7.[3] Here the embryonic development is already far advanced, consequently I was not able

[1] The eggs of *Nymphon hamatum*, *N. longicoxa*, and *N. fuscum* were so far advanced in development that in them only the different larval stages could be studied.

[2] Dohrn, *loc. cit.*, p. 139, says that the egg of *Pycnogonum litorale* has a double membrane, and that these membranes are found in the ovary, an assertion not corresponding with the observations I made on the eggs of *Nymphon*.

[3] Between the stage figured in fig. 7 and the foregoing, numerous other stages were observed; but in these the cellular structure was so totally spoiled by the action of the alcohol, that I dare not give drawings or descriptions of them. The only means of distinguishing the embryonic cells from the deutoplasm is by the colouring of the cells with picrocarmine, and there can be little doubt that one of the first changes the blastoderm undergoes consists in the formation of a longitudinal thickening of it at the future ventral side of the embryo. This thickening terminates rather abruptly at the anterior end, but at the posterior end it slopes gradually to the unicellular part of the blastoderm. Afterwards a longitudinal furrow seems to take rise in the middle of this thickening, the inner part of which is finally isolated in the form of a longitudinal tube. I publish these details only with the strongest reserve, the condition of the eggs and the circumstance that the sections are necessarily taken in quite uncertain directions, making the giving of a decided description impossible.

to study the formation of the germ-layers, nor the modifications which they undergo during development. Whether all the cells of the embryo in this stage are derived exclusively from the blastoderm, or whether they are also partly due to the deutoplasm is a question which it is impossible to answer from the section before me. Dorsally the greater part of the embryo is covered by a single row of flattened cells (the original blastoderm cells), ventrally a plate is clearly distinguished much thicker than the blastoderm, and doubtless formed of cells more than one row deep. Unfortunately, however, the limits of these cells were quite gone; I therefore could not distinguish either their number or arrangement, but I believe the evidence is great that in the inner layer of this plate the original mesoblast is to be seen. In this stage rudiments of the appendages are distinctly formed; and I consider it a very characteristic feature in the development of the Pycnogonids, that the food-yolk penetrates into these appendages. In the section here figured, however, that part of the food-yolk which penetrates the leg, is not in direct connection with the central food-yolk mass; but this is caused by the circumstance, that the section does not pass exactly vertically through the embryo, but goes a little obliquely from above backwards to the ventral side.

The blastoderm shows to a considerable extent in the stage I have figured a double cell-layer dorsally in the middle, and even a small lumen is observed between these two. Small cells or nuclei seem to be present in this lumen, and the whole arrangement made me think it possible that I had an early stage in the development of the heart before me. The broad and flattened condition of the heart in the adult animal of *Nymphon* is not opposed to this suggestion; yet it is difficult to understand why a heart should be developed before there seems to be any question of an intestinal tract.

About the same stage is also figured in figs. 9 and 10. At the ventral side the first pair of appendages (the foot-jaws), three pairs of legs, between the foot-jaws the proboscis, and the caudal protuberance, are easily distinguished. The second and third pair of cephalic appendages show in this species a remarkable retardation in their appearance, visible in the stage in which the first and second pair of true legs are already two-jointed and bent inwards so as to meet in the middle of the ventral surface, and in which the third pair is longer, yet bent inwards and forwards. In this same stage the third cephalic appendage is not yet distinguishable, and the second pair only shows a small protuberance at the base of the foot-jaws. An equatorial section of an embryo in this same stage is figured in fig. 11. Between the foot-jaws (*a*) and the first true leg (*b*) two small protuberances are distinguished, the first of which (*c*) is larger than the second (*d*), which in this stage is observed only interiorly. The section is also remarkable for the distinctness with which the nerve ganglia are seen.

There is good reason to consider this arrangement characteristic for the species *Nymphon brevicaudatum*, Miers. Other species of *Nymphon*, of course, may show the same; so far as I could ascertain it is not the rule, for neither *Nymphon*

brachyrhynchus nor *N. brevicollum* nor *N. hamatum* agree with *N. brevicaudatum* in this regard. Fig. 8 shows a stage in the development of *Nymphon brachyrhynchus*, in which the three first pairs of embryonic appendages are already present. The first pair (the largest) are armed with pincers; the second and third are small, armed with curved hooks and not taking parts of the food-yolk; of the true legs in this stage nothing as yet is to be seen. In figs. 12 and 13 I have figured a larva of *Nymphon brevicollum* showing the three cephalic appendages, the first pair of true legs almost completely developed, the second pair much shorter than the first, and not yet furnished with claws, the third only as a rudimentary process; the fourth pair is totally wanting in this stage. Consequently I believe it is the rule in *Nymphon*, that the three pair of cephalic appendages are developed first of all, the legs appearing afterwards in regular succession.

To return to *Nymphon brevicaudatum*, Miers, in figs. 9 and 10, I have figured embryos within the shell of the egg almost of the same stage; with this difference only, that in fig. 10 the egg is figured as seen from the ventral surface. In fig. 9 also, a part of the dorsal surface being bent over to the ventral side has been drawn. In this last figure it is clearly shown that the dorsal surface of the embryo is at least at the anterior side lined with a shell-like thickening, the proboscis and the first pair of cephalic appendages being at their origin covered by this thickening as by a cap. Near the anterior side of this cap the double supra-œsophageal ganglion is situated, making it evident that in the border of this cap the anterior margin of the cephalic part of the embryo is to be seen; the proboscis being only an azygous excrescence of that part of the ventral surface which surrounds the mouth.

The equatorial section figured in fig. 11 shows the distribution of the nerve ganglia on the ventral surface; the first and second ganglia are smaller and are placed close to each other; the development of the third, fourth, and fifth ganglia is in near relation with that of the corresponding legs; finally, neither the sixth ganglion nor the fourth pair of legs is to be distinguished. In the middle the two halves of every ganglion are placed close to each other, which, as far as I could ascertain, is also the case in earlier stages. Of the longitudinal commissures between the ganglia in this stage, nothing as yet is to be distinguished, and as to the cellular structure of the ganglia, I was only able to trace large cells without any differentiation.

The degree of development the larvæ have reached when leaving the shell of the egg is not the same for all the species of *Nymphon*; so I think it probable that the larva of *Nymphon brevicaudatum*, Miers, does not creep out of the egg before the four true legs are developed, whereas the young of *Nymphon brevicollum* cling to the ovigerous legs of the father as soon as only one of the pairs of true legs has reached its full development, and perhaps even earlier yet. So, when Semper affirms that there occurs a complete metamorphosis in the development of the species of the genus *Nymphon*, two points are to be borne in mind, (1) that this does not affect all the species of *Nymphon* in

the same way, and (2) that here the word metamorphosis has quite a different meaning from what it has in entomology.

Of the genus *Nymphon* I was able to compare the larvæ of the species *Nymphon brevicollum*, *N. hamatum*, and *N. longicoxa*. Of *Nymphon brevicollum* I have figured the youngest stage observed in figs. 12 and 13; an older one, which has three pairs of legs fully developed and the fourth already planned in the form of two lateral processes, has been drawn from the ventral side in fig. 1 of Plate XX.

On the ovigerous legs of the same animal I found together larvæ in both the stages I have figured, and also in intermediate stages. Taking a small number of these larvæ from the leg to study them under the microscope, I often observed the membranes of earlier stages between them. These membranes, and especially the parts which belong to the fore-part of the body, are attached to one another by means of long threads; these threads take their origin in the first joint of the foot-jaw, which bears a protuberance perforated by the thread. In the interior of the joint, and also of the empty membrane of this joint the thread can be traced a short way, but in neither to a great extent, as in the joint it is covered by the food-yolk, and in the membrane soon ceases after having passed the protuberance.

The larvæ of *Nymphon hamatum* which I was able to study were already furnished with four legs. Their condition was not extremely favourable for minute investigation, especially because the food-yolk makes the whole body opaque. The third pair of cephalic appendages are but small, and have each the form of a two-jointed stump bearing a pair of small spines at the extremity. The fore-part of the body of this larva is figured in fig. 3, Plate XX. An apparatus of a very singular shape, and, of course, closely connected with the protuberance perforated by the long thread in the larva of *Nymphon brevicollum*, is situated as in that species in the first joint of the foot-jaw. Numerous bottle-shaped sacs are placed near each other, and in such a way that their necks meet in one point. Each neck terminates in a small semilunar border, which covers a small slit; through this slit a thread passes, that can be easily observed as it runs through the throat of the bottle-shaped sac. The widened part of the bottle has in its interior two or more vesicles, which seem to be filled with an opaque protoplasm, covering in all probability the origin of the thread. Every bottle has its own thread, and of these more than ten are easily counted. I have figured this apparatus in fig. 4, Plate XX. The study of the apparatus is very difficult, as it is not transparent, being covered at one side by the food-yolk. The different bottle-shaped sacs are enclosed in a granular mass, with which very fine fibres seem to correspond. I could follow these fibres to a certain distance from the apparatus, where they are covered by the food-yolk; and from their pale appearance, and the circumstance that they are not easily coloured by picrocarmine (as the muscles, fig. 4, are), I felt inclined to look upon them as nerve-fibres.

The same organ, but of a somewhat different shape, occurs also in the mandibles of

the larvæ of *Nymphon longicoxa.* These larvæ in almost every detail correspond with those of *Nymphon hamatum,* but the organ here in question is a curious exception. I have figured it in fig. 5 of Plate XX. Numerous small vesicles are in close relation with each other, and are so placed that they seem to radiate from a common centre. The whole apparatus is small; fig. 5 shows a drawing enlarged 270 times. The vesicle corresponds in all probability with a larger one placed in the centre, sending forth the thread, which in this species is always a single one. The thread is a little swollen at the foot, and seems (to judge from the double lining under the skin) to run through a sheath, at the end of which a semilunar border covers a small slit, through which the thread passes. Of course the chitinous skin of the larva is not coloured by the picrocarmine, but the broad and flat thread is. This thread is very long, its length sometimes equalling and even surpassing half the length of the larva; at a certain distance from the beginning I repeatedly observed a small part of the old skin, which remained in relation with the thread, while the larva got a new one.

A similar apparatus to the one described by me for the larvæ of *Nymphon hamatum* and *Nymphon longicoxa* (and occurring in all probability also in *Nymphon brevicollum*) has been observed by Dohrn in the larva of *Achelia.* The first joint of the mandible bears a strong spine in the larva. "An diesem letzteren sieht man fast immer einen sehr feinen Faden befestigt und erkennt bei näherer Untersuchung, dass dieser Faden aus dem Dorn herauskommt. Der Dorn ist nämlich hohl, seine Spitze durchbohrt und im Inneren sieht man einen zweiten feinen Canal der von einem merkwürdig gestalteten Organ ausgeht, das in der Basis des ersten Gliedes der Scheerenfüsse liegt. Das Organ hat die Gestalt eines Kartenherzens, die Spitze ist verlängert in den eben erwähnten Canal, der anfänglich etwas breiter sich bald verschmälert und quer durch den Innenraum des Beines sich zu dem Dorn begiebt. Der Canal ist nicht häutig, sondern hornig, dennoch beugt er sich in mässiger Krümmung, ehe er den Dorn erreicht. Die Structur der Drüse—denn für eine solche muss ich das sonderbare Organ halten—habe ich nicht ermitteln können, nur so viel vermag ich anzugeben, dass die hintere Hälfte aus kleinen Zellen bestand, die dem Organ eine gewisse Aehnlichkeit mit einem Nervenganglion verliehen, während die vördere Hälfte von zwei merkwürdigen blassen Flecken eingenommen wurde, die Kugelgestalt besitzen, aber nicht erkennen liessen, ob sie mit irgend einer Substanz gefüllt waren, oder Hohlkugeln darstellten. Ueber und unter dieser Drüse liegen Muskeln, welche zur Bewegung des zweiten Gliedes der Extremität dienen." [1]

There remains no doubt that the organ of Dohrn is the same as that observed by me. Also, as I already said above, I feel very much inclined to adopt the conjecture about the character of the organ proposed by him. The organ is a gland, and the product of its secretion consists of one or more fine threads. These threads occur only in the larval condition, and as for their use I wish to compare them with the byssus threads of the Lamelli-

[1] Dohrn, *l. c.*, p. 141.

branchiata. The larvæ of different species, as observed by me, usually remain for a long time after having cast off their exuviæ, in relation to the ovigerous leg of their parent. As long as they were enclosed in their egg, they clung together tightly enough; but once crept out of the egg-shell, a special arrangement is necessary to keep them together. This is found in the threads, and the supposed glands from which these take their origin, as observed by Dohrn and me. Repeatedly I saw, as I have mentioned already before, between the larvæ of *Nymphon brevicollum*, collections of very numerous skins held together by means of the threads, and small parts of such a cast skin I found also in relation with the thread of the larvæ of *Nymphon longicoxa*.

It is true that the structure of the apparatus, as it shows itself in the larva of *Nymphon hamatum*, argues, perhaps, for the conjecture that the organ is an organ of sense, but then it is exceedingly strange that such an organ should only be found within the larvæ. And it would be difficult to explain the meaning of the single or numerous long threads as being sent forth from an organ of sense, whereas in relation with a gland their function can easily be understood.

The study of this same organ which I made last summer in the laboratory of Prof. Lacaze-Duthiers, at Roscoff, has also convinced me, that my original supposition as to the function of these organs was erroneous. The fine threads, which I observed in the interior of the mandible running towards the organ are threads of connective tissue; their function is, no doubt, to hold the organ in its place. The young of *Nymphon robustum*, Bell, and those of *Nymphon brevicaudatum*, Miers, are a great deal more developed when creeping out of the egg than those of *Nymphon hamatum*, *N. longicoxa*, and *N. brevicollum*. Most probably this spinneret of the larva does not occur in these species.

Besides the larvæ of the genus *Nymphon*, the only other genus of which I could investigate the larvæ was *Ascorhynchus*. About their development and metamorphosis nothing as yet has been published. I can only give a drawing of the single larval stage which I observed, and which is furnished with three pairs of legs. The fig. 6 on Plate XX. shows that the larva in this stage corresponds with larvæ of other genera, as observed by Kröyer, Dohrn, and myself. Of the glands in the foot-jaw no trace could be discovered; but then the larvæ are very small, and their condition is not very good.

8. In studying the anatomy of the Pycnogonids of the Challenger Expedition, I met with two different kinds of bodies of which I have not been able to ascertain whether they really belong to the organisation of the Pycnogonids, or must be considered as parasites. However, I feel much inclined to adopt the latter opinion; and although some doubt remains, I wish to give a short description of what I have seen, which may, perhaps, be of use for later investigators.

In the first place I met with some curiously shaped forms in the interior of the body and of the legs of two different species of *Nymphon*. I observed them in *Nymphon longicoxa* and in *Nymphon brevicaudatum*, but only in some of the specimens which belonged to

the male as well as to the female sex. They are comparatively large, often long ovate cells with a thin wall, the contents consisting of large granules and a longitudinal slightly curved nucleus.

When colouring the preparations with picrocarmine these forms assume a yellow colour, the nucleus becoming beautifully red. They seem to be distributed through the body very irregularly and seem to penetrate all the cavities accessible to the blood. In *Nymphon brevicaudatum* I even observed them in the space before occupied by the eggs, and in which still an unripe egg was to be seen. Both in this species and in *Nymphon longicoxa* most of these curious forms are very regularly placed against the wall of the leg, where they often form two or even more distinct layers. Their size varies between 0·066 and 0·081 mm. With regard to their nature my opinion is not at all a settled one; but I am strongly inclined to believe them to be the eggs of some parasitic animal. But what kind of animal their parent in that case will prove to be I am unable to say.

The other kind of bodies must be regarded, I believe, as ectoparasites of *Colossendeis leptorhynchus.* Of the ten specimens of this species in the Challenger collection there are three which are sprinkled over with these. The one is a male, the two others are female.

They are rounded, sac-forming bodies, often with a crumpled surface placed at the end of a short stalk, the end of the stalk is in connection with the integument of the Pycnogonid. Their wall is chitinous, and under this outer wall there is a much thinner inner one; in the stalk this inner wall is close to the outer one, but in the globular part there is a large open space between the outer and the much smaller inner sac. In this space pressed against the outer sac numerous eggs are found, the size of which is 0·088 mm., they have a very thin wall and are furnished with a yelk of large rounded elements, coloured yellow by picrocarmine. A small nucleus as a red coloured spot, however, is always present.

Whether these are really eggs is the first question to be answered, and I think there can be no doubt in respect to this. Moreover, to judge from their structure and that of the capsules, they are eggs that are laid after having been fecundated. There is only one consideration, I believe, that may be set against this suggestion, and this is, that all these eggs are in the same state of development; not only those of the same capsule, but of all the capsules I investigated. It must be borne in mind, however, that these were brought up by the same haul of the trawl, and probably lived in the neighbourhood of one another; consequently I think this objection is of no importance.

The second question is whether they are the eggs of that Pycnogonid on the legs of which they are found, or of another specimen of the same species, or of any other animal. Of course it is possible that the eggs are *Colossendeis* eggs; however, I do not think this very probable. In the first place, because males and females both are studded with these capsules, and in the second place, because these capsules are totally different from the egg-masses commonly found on the ovigerous legs of the Pycnogonids. In favour of

this opinion may be advanced that—at any rate as far as I know—hitherto no specimen of one of the known species of *Colossendeis* has been caught with egg-masses on its ovigerous legs. Considering that they are not the eggs of the *Colossendeis* itself, it becomes almost impossible to form an opinion as to the animal they belong to. Among the gastropodous molluscs numerous forms are known, which construct egg-capsules, and attach them to foreign bodies. Perhaps the present capsules belong to an animal of that group. That the long legs of our animals may easily be mistaken by other animals for dead bodies is shown, I believe, by the fact that numerous other animals, which cannot be considered as parasites, and which, as a rule, are found on stones, shells of molluscs, carapaces of crabs, &c., fix themselves on these legs. So a small sponge and a polyzoon are on *Nymphon brachyrhynchus*, a stalk-like process most probably of a tubularian polyp is found on the leg of a *Colossendeis*; a species of *Scalpellum* is extremely numerous on the legs of *Nymphon robustum*, Bell. Of the numerous specimens of this species collected in Barents Sea, which I have investigated, there is not a single one with these ectoparasites. But on the other hand, they are very common on the hundreds of specimens of this species which were obtained by the "Knight-Errant." Professor G. O. Sars enumerates in his two latest papers on the Crustaceans of the Norwegian Expeditions numerous species of *Scalpellum*, found at higher northern latitudes, but he does not mention that they are found on the legs of the most common Pycnogonid of the North Atlantic and North Polar Sea. Moreover, a preliminary comparison of this species of *Scalpellum* shows differences with those described. I therefore believe it to be a new one, and wish to name it *Scalpellum nymphocola*.

SUMMARY OF THE REPORT.

1. Of the forty-one species of Pycnogonida dredged during the voyage of H.M.S. Challenger and the cruise of the "Knight-Errant" thirty-three are new to science.

2. Of the nine genera represented in those collections three are new.

3. Those genera which range most widely geographically are also those which range most widely in depth.

4. There are deep-sea species, but true deep-sea genera do not seem to exist.

5. The Pycnogonida form a distinct and very natural group (class) of arthropodous animals. Their common progenitor (their typical form) must be considered as a hypothetical Pycnogonid with three-jointed mandibles, multi-jointed palpi, and ovigerous legs with numerous rows of denticulate spines on the last joints.

6. This class of the Arthropoda may be thus characterised :—Arthropoda breathing by the general surface of the body, which body consists of a cephalothoracic, three thoracic segments, and a rudimentary abdominal segment. The cephalic part of the cephalothoracic segment bears anteriorly a proboscis, consisting of three coalesced parts, one præ-oral (labrum ?), two post-oral ones (mandibles ?), and three pair of cephalic appendages, the first two of which in the adult state sometimes have become rudimentary, the third pair being always present at least in one of the two sexes. The first pair of these appendages represents the antennæ, the two others are post-oral. The thoracic part of the cephalothoracic segment and the three thoracic segments are each furnished with a pair of long eight-jointed legs, into which the alimentary canal sends off long cœca.

7. The function of the integumentary cavities is primarily respiratory.

8. The typical form of the nervous system shows a supraœsophageal and five thoracic ganglia. The supraœsophageal ganglion gives off the nerves for the mandibles (antennæ), the integumentary nerves, and a strong nerve for the proboscis. Besides these it probably gives off nerves for the intestine (sympathic nerves). The first thoracic ganglion consists of two coalesced ganglia, and gives off four pairs of nerves, two pairs innervating the proboscis, then the pair of palpar nerves, and finally those for the ovigerous legs. The following four ganglia give off the nerves for the four pairs of legs ; the last ganglion gives sometimes two sometimes one pair of nerves for the abdomen.

9. In addition to the nerves mentioned above the proboscis is innervated by three strong bundles of nerves and ganglia united by a stronger and some feebler secondary œsophageal nerve rings.

10. In some genera the inner surface of the integument is covered by a net-work of nerves and ganglia in connection with, and most probably issuing from, the integumentary nerves given off by the supraœsophageal ganglion.

11. In the most primitive condition the eye of the Pycnogonid consists of a rounded transparent part of the integument, the inner surface of which is furnished with some small ganglia and nerve-fibres issuing from the integumentary nerve bundle. The highly developed eye of the shallow-water species shows ganglionic cells, distinct retinal rods, and a lens consisting of a thickened part of the chitinous skin of the animal.

12. Those eyes which have lost their pigment and their retinal rods are rudimentary. They cannot be considered as forming the transition between the highly-developed eye and its most primitive condition.

13. That part of the œsophagus which runs through the proboscis has the function of a masticating apparatus. Where the œsophagus enters the intestinal tract (the stomach) small glands (pancreatic, most probably) are present.

14. The original condition of the genital glands is in the form of a U-shaped mass, placed above the intestine and giving off branches which penetrate the legs. Whereas for the male glands the original form prevails in most (all ?) genera, for the female glands it seems to be a rule that only the lateral parts entering the legs are developed. The genital pores of the females are larger than those of the males; they are found ventrally towards the extremity of the second joint of the leg. Whereas for the females it is the rule that these pores are present on all the legs; it often happens in the males that they are only present on the two or three hindmost pair of legs.

15. There are always distinct vasa efferentia, but there are not always true oviducts.

16. In *Nymphon brevicaudatum*, Miers, females also bear the eggs on the ovigerous legs.

17. The larva creeping out of the egg is already furnished with an azygous outgrowth of the region surrounding the mouth (the proboscis). As a rule in that stage only three pairs of appendages (the later cephalic ones) are present.

18. These larvæ are often furnished on their mandibles with an apparatus producing a single or numerous threads, wherewith the young is attached to the ovigerous leg of its parent.

19. About the relation in which the Pycnogonida stand to either the Crustacea or the Arachnida we know as much or as little as we do about the relation in which these two classes Arthropoda stand to each other.

Note.—While I was engaged in preparing the index of this report, and after the rest of it had been printed off, Mr Edmund B. Wilson of Baltimore kindly sent me two papers which he had recently published. In one (the Pycnogonida of New England and Adjacent Waters, Report of the United States Commissioner of Fish and Fisheries, part vi. for 1878, pp. 463–506, pls. i.–vii.) the author gives an account of the present know-

ledge of the species of Pycnogonida known to occur on the coasts of New England and Nova Scotia. With two exceptions (*Achelia scabra*, Wilson, and *Nymphon macrum*, Wilson) the species here described are the same as those of a former paper by Mr Wilson, published in the Trans. Connect. Acad. Sci., vol. v. pp. 1–26, 1880. The new *Achelia* is quite unknown to me, but *Nymphon macrum*, Wils., is undoubtedly the species which I have described in my report (p. 45) as *Nymphon brevicollum*. The Challenger specimens were taken south of Halifax (83 fathoms), those described by Mr Wilson in the Gulf of Maine (85 to 115 fathoms).

The other paper (Reports on the Results of Dredging, under the Supervision of Alexander Agassiz, along the East Coast of the United States, during the summer of 1880, by the United States' Coast Survey Steamer "Blake," Commander J. R. Bartlett, U.S.N., commanding. xiii. Report on the Pycnogonida, by Edmund B. Wilson; Bulletin of the Museum of Comparative Zoölogy at Harvard College, vol. viii., No. 12, Cambridge, Mass., March 1881, pp. 239–256, pls. i.–v.) contains descriptions of ten species of Pycnogonids, five of which are new. These belong to three genera, two of which are considered by the author as new. The new species are in the first place two species of *Colossendeis*, Jarzynsky, *Colossendeis colossea*, and *Colossendeis macerrima*. Then a new genus *Scaeorhynchus*, with the species *Scaeorhynchus armatus*, is proposed; finally, the new genus *Pallenopsis*, with the species *Pallenopsis forficifer* and *Pallenopsis longirostris*, is described. The descriptions are illustrated by very good figures. On comparing these figures and descriptions with those of my report, there can be little doubt that *Colossendeis colossea* and *C. macerrima* are very nearly related to, if not identical with, my *Colossendeis gigas* and *C. leptorhynchus*. As to the genus *Scaeorhynchus*, I do not think there are sufficient grounds for separating it from *Ascorhynchus*, G. O. Sars. Neither the presence of dactyli on the first pair of legs, nor the structure of the rudimentary mandibles (antennae) makes it proper to separate these genera: *Scaeorhynchus* (like *Gnamptorhynchus*, Böhm) is only a synonym of *Ascorhynchus*. The species *armatus*, Wilson, seems to be different from those hitherto described, and also from those of the present report.

The new genus *Pallenopsis* is intended to embrace those species which come near to *Phoxichilidium*, but which are characterised by ten-jointed accessory legs present in both sexes, and by three-jointed mandibles. Three (perhaps four) species described in my report show these characters also, and (pp. 82 and 88) I have been long in doubt whether I should not propose a new genus for these species. I did not take the step because I do not wish to augment the number of genera more than necessary until our knowledge of generical characters is more perfect. Mr Wilson is not so slow in proposing new genera; in the present instance, I believe, however, that his proposal has a fair chance of being accepted. The two species described by Mr Wilson are, I believe, different from those described in my report.

I regret very much that in my report species will be found mentioned, described, and figured as new, which at the date of its publication will have been already described. As I was aware of the large collections of deep-sea animals collected by Professor Alexander Agassiz, and felt sure that my report, with its numerous plates, would take a considerable time in passing through the press, I took the liberty of writing to Professor Agassiz, to ask him to whom the working-out of the Pycnogonids of his latest cruises had been entrusted. He kindly complied with my request, and informed me that the Pycnogonids along with the Crustacea had been sent to Professor Alphonse Milne-Edwards in Paris. I then addressed Professor Milne-Edwards, sending him at the same time proof-copies of the plates of my report on which the new species were figured, and as he favoured me with an answer, in which he promised to make use of the names proposed by me, I had every reason to believe that zoological literature, at least in the case of the deep-sea Pycnogonida, would not be encumbered by synonyms. Where I have not been successful in this respect I hope nobody will lay the blame upon me.

Leiden, 19*th May* 1881.

EXPLANATION OF PLATES.

PLATE I.

Nymphon hamatum, n. sp. (figs. 1–9).

Fig. 1. Male, dorsal view; magnified 3 diameters.
,, 2. Male, ventral view; magnified 7 diameters.
,, 3. The claws of the mandibles; magnified 41 diameters.
,, 4. The last four joints of the ovigerous legs; magnified 34 diameters.
,, 5. The denticulate spines of the ovigerous legs; magnified 272 diameters.
,, 6. The second coxal joint of the leg of a female; magnified 6 diameters.
,, 7. The tubercles on the thigh of the male; magnified 94 diameters.
,, 8. The hook-like process at the end of the thigh; magnified 41 diameters.
,, 9. The last two joints and the claw of one of the legs; magnified 21 diameters.

PLATE II.

Nymphon longicoxa, n. sp. (figs. 1–5).

Fig. 1. Male, dorsal view; magnified $7\frac{3}{4}$ diameters.
,, 2. The last four joints of the palpus; magnified 20 diameters.
,, 3. The claws of the mandibles; magnified 94 diameters.
,, 4. The denticulate spines of the ovigerous legs; magnified 272 diameters.
,, 5. The last two joints and the claw of one of the legs; magnified 41 diameters.

Nymphon compactum, n. sp. (figs. 6–8).

Fig. 6. Female, ventral view; magnified $6\frac{1}{2}$ diameters.
,, 7. Part of the body of a female, dorsal view; magnified 8 diameters.
,, 8. The denticulate spines of the ovigerous legs; magnified 272 diameters.

Nymphon procerum, n. sp. (figs. 9–12).

Fig. 9. Female, dorsal view; magnified $6\frac{3}{4}$ diameters.
,, 10. The claws of the mandibles; magnified 94 diameters.
,, 11. The claw of the ovigerous leg; magnified 94 diameters.
,, 12. The denticulate spines of the ovigerous legs; magnified 272 diameters.

PLATE III.

Nymphon longicollum, n. sp. (figs. 1–3).

Fig. 1. Male, dorsal view; magnified $6\frac{3}{4}$ diameters.
,, 2. The same, seen ventrally; magnified 20 diameters.
,, 3. The claws of the mandibles; magnified 47 diameters.

Nymphon meridionale, n. sp. (figs. 4–8).

Fig. 4. Male, dorsal view; magnified 20 diameters.
,, 5. The claws of the mandibles; magnified 94 diameters.
,, 6. Claw and last part of the tenth joint of the ovigerous leg; magnified 272 diameters.
,, 7. The last two joints of the leg; magnified 41 diameters.
,, 8. The claw with one of the secondary claws of one of the legs; magnified 136 diameters.

Nymphon grossipes, Fabr. (sp.), (figs. 9–12).

Called *Nymphon armatum*, n. sp., at the foot of the plate.

Fig. 9. Male, ventral view; magnified $6\frac{3}{4}$ diameters.
,, 10. The claws of the mandibles; magnified 41 diameters.
,, 11. The denticulate spines of the ovigerous legs; magnified 575 diameters.
,, 12. The last joint of the leg of a female; magnified 41 diameters.

Nymphon brevicollum, n. sp. (figs. 13–15).

Fig. 13. Female, ventral view; magnified $6\frac{3}{4}$ diameters.
,, 14. Claw and last part of the tenth joint of the ovigerous leg; magnified 272 diameters.
,, 15. Claw with one of the secondary claws of the leg; magnified 94 diameters.

PLATE IV.

Nymphon grossipes, Fabr. (sp.) (fig. 1).

Called *Nymphon armatum*, n. sp., at the foot of the plate.

Fig. 1. Oculiferous tubercle; magnified 41 diameters.

Nymphon brachyrhynchus, n. sp. (figs. 2–7).

Fig. 2. Male, dorsal view; magnified 41 diameters.
,, 3. Female, ventral view; magnified $6\frac{3}{4}$ diameters.

Fig. 4. The claws of the mandibles; magnified 94 diameters.
„ 5. Palpus; magnified 41 diameters.
„ 6. Claw of the ovigerous leg; magnified 272 diameters.
„ 7. Claw of one of the legs; magnified 94 diameters.

Nymphon fuscum, n. sp. (figs. 8–11).

Fig. 8. Male, ventral view; magnified $6\frac{3}{4}$ diameters.
„ 9. The claws of the mandibles; magnified 94 diameters.
„ 10. Palpus; magnified 41 diameters.
„ 11. Claw of the ovigerous leg; magnified 180 diameters.

Nymphon brevicaudatum, Miers (figs. 12–13).
Called *Nymphon hispidum*, n. sp., at the foot of the plate.

Fig. 12. Male, dorsal view; magnified 12 diameters.
„ 13. Male, ventral view; magnified 6 diameters.

PLATE V.

Nymphon brevicaudatum, Miers (figs. 1–5).
Called *Nymphon hispidum*, n. sp., at the foot of the plate.

Fig. 1. Palpus; magnified 41 diameters.
„ 2. Claws of the mandibles; magnified 41 diameters.
„ 3. Last five joints of the ovigerous leg; magnified 41 diameters.
„ 4. Denticulate spine of the ovigerous leg; magnified 272 diameters
„ 5. Last two joints of the leg; magnified 34 diameters.

Nymphon perlucidum, n. sp. (figs. 6–10).

Fig. 6. The front part of the body, seen ventrally; magnified 41 diameters.
„ 7. The whole animal, dorsal view; magnified $6\frac{3}{4}$ diameters.
„ 8. The last four joints of the ovigerous legs; magnified 94 diameters.
„ 9. Two of the denticulate spines of the ovigerous leg; magnified 272 diameters.
„ 10. The last two joints of the leg; magnified 36 diameters.

Ascorhynchus orthorhynchus, n. sp. (figs. 11–13).

Fig. 11. Dorsal view; magnified $3\frac{1}{2}$ diameters.
„ 12. Ventral view; magnified 2 diameters.
„ 13. Palpus; magnified 21 diameters.

PLATE VI.

Ascorhynchus orthorhynchus, n. sp. (figs. 1–4).

Fig. 1. Rudimentary mandible; magnified 94 diameters.
" 2. The last four joints of the ovigerous leg; magnified 21 diameters.
" 3. The denticulate spines of one of the joints of the ovigerous leg; magnified 272 diameters.
" 4. The last two joints of the leg; magnified 21 diameters.

Ascorhynchus glaber, n. sp. (figs. 5–9).

Fig. 5. Dorsal view; magnified $5\frac{1}{2}$ diameters.
" 6. Mandibles; magnified 21 diameters.
" 7. The mandible of a young specimen; magnified 94 diameters.
" 8. The last four joints of the ovigerous leg; magnified 21 diameters.
" 9. The last joint of the leg; magnified 21 diameters.

Ascorhynchus minutus, n. sp. (figs. 10–16).

Fig. 10. Ventral view; magnified $7\frac{1}{3}$ diameters.
" 11. Side view; magnified $7\frac{1}{3}$ diameters.
" 12. The last three joints of the ovigerous leg; magnified 70 diameters.
" 13. The eighth joint of the ovigerous leg; magnified 182 diameters.
" 14. The last two joints of the leg; magnified 70 diameters.
" 15. The last joint of the first leg; magnified 94 diameters.
" 16. Hairs of the palpus; magnified 272 diameters.

PLATE VII.

Oorhynchus aucklandiæ, n. sp. (figs. 1–7).

Fig. 1. Ventral view; magnified 15 diameters.
" 2. Dorsal view; magnified $7\frac{1}{2}$ diameters.
" 3. The front part seen dorsally; magnified 34 diameters.
" 4. Palpus; magnified 94 diameters.
" 5. The last four joints of the ovigerous leg; magnified 130 diameters.
" 6. One of the legs; magnified 34 diameters.
" 7. The last two joints of the leg; magnified 70 diameters.

Discoarachne brevipes, n. sp. (figs. 8–12).

Fig. 8. Dorsal view; magnified 8 diameters.
„ 9. Ventral view; magnified 8 diameters.
„ 10. Palpus; magnified 94 diameters.
„ 11. The last four joints of the ovigerous leg; magnified 94 diameters.
„ 12. The last two joints of the leg; magnified 94 diameters.

PLATE VIII.

Colossendeis gigas, n. sp. (figs. 1–2).

Fig. 1. Ventral view; natural size.
„ 2. Dorsal view of the body; natural size.

Colossendeis leptorhynchus, n. sp. (figs. 3-7).

Fig. 3. Ventral view; natural size.
„ 4. Dorsal view of the body; natural size.
„ 5. The last four joints of the palpus; magnified 30 diameters.
„ 6. The last four joints of the ovigerous legs; magnified 21 diameters.
„ 7. The claw of one of the legs; magnified 48 diameters.

PLATE IX.

Colossendeis megalonyx, n. sp. (figs. 1–3).

Fig. 1. Lateral view; magnified 2 diameters.
„ 2. The last three joints of the palpus; magnified 39 diameters.
„ 3. The arrangement of the denticulate spines on the ninth joint of the ovigerous leg; magnified 94 diameters.

Colossendeis robusta, n. sp. (figs. 4, 5).

Fig. 4. Dorsal view; magnified 2 diameters.
„ 5. The arrangement of the denticulate spines on the ninth joint of the ovigerous leg; magnified 41 diameters.

Colossendeis gracilis, n. sp. (figs. 6–8).

Fig. 6. Ventral view; magnified 5 diameters.
„ 7. The last four joints of the palpus; magnified 41 diameters.
„ 8. The arrangement of the denticulate spines on the ninth joint of the ovigerous leg; magnified 235 diameters.

PLATE X.

Colossendeis gigas, n. sp. (figs. 1–5).

Fig. 1. The arrangement of the denticulate spines at the ninth joint of the ovigerous leg; magnified 41 diameters.
„ 2. One of the denticulate spines of the ninth joint of the ovigerous leg of an old specimen; magnified 136 diameters.
„ 3. The same of an outside row of a younger specimen; magnified 136 diameters.
„ 4. The same of an inside row of a younger specimen; magnified 136 diameters.
„ 5. Two rudimentary spines of a row quite to the inside of an old specimen; magnified 136 diameters.

Colossendeis gracilis, n. sp. (figs. 6–7).

Fig. 6. Specimen with mandibles, dorsal view; magnified 6½ diameters.
„ 7. The arrangement of the denticulate spines on the ninth joint of the ovigerous leg; magnified 94 diameters.

Colossendeis brevipes, n. sp. (figs. 8–9).

Fig. 8. The last five joints of the palpus; magnified 20 diameters.
„ 9. The arrangement of the denticulate spines on the ninth joint of the ovigerous leg; magnified 94 diameters.

Colossendeis minuta, n. sp. (figs. 12–14).

Fig. 12. Dorsal view; magnified 6 diameters.
„ 13. The last five joints of the palpus; magnified 41 diameters.
„ 14. The arrangement of the denticulate spines on the ninth joint of the ovigerous leg; magnified 272 diameters.

PLATE XI.

Pallene australiensis, n. sp. (figs. 1–7).

Fig. 1. Ventral view; magnified 7 diameters.
„ 2. Dorsal view; magnified 17 diameters.
„ 3. Claws of the mandibles; magnified 94 diameters.
„ 4. Last five joints of the ovigerous leg of the male; magnified 34 diameters.
„ 5. Ninth joint of the ovigerous leg of the male; magnified 270 diameters.
„ 6. Last two joints of the leg; magnified 65 diameters.
„ 7. Spine on the sixth joint of the leg; magnified 270 diameters.

Pallene lævis, n. sp. (figs. 8–12).

Fig. 8. Female specimen, dorsal view; magnified 6 diameters.
„ 9. Female specimen, ventral view; magnified 17 diameters.
„ 10. Last four joints of the ovigerous leg; magnified 65 diameters.
„ 11. Last joint of the ovigerous leg; magnified 272 diameters.
„ 12. Last two joints of the leg; magnified 41 diameters.

PLATE XII.

Pallene languida, n. sp. (figs. 1–5).

Fig. 1. Ventral view; magnified 41 diameters.
„ 2. Dorsal view; magnified 41 diameters.
„ 3. Last joint of the mandible; magnified 94 diameters.
„ 4. Last five joints of the ovigerous leg; magnified 94 diameters.
„ 5. Denticulate spines of the ovigerous leg; magnified 575 diameters.

Phoxichilidium patagonicum, n. sp. (figs. 6–9).

Fig. 6. Dorsal view, natural size.
„ 7. Ventral view; magnified 6 diameters.
„ 8. Last four joints of the ovigerous leg; magnified 36 diameters.
„ 9. Last two joints of the leg; magnified 6 diameters.

Phoxichilidium patagonicum, var. *elegans*, Hoek (fig. 10).

Fig. 10. Ventral view; magnified 8 diameters.

PLATE XIII.

Phoxichilidium oscitans, n. sp. (figs. 1–5).

Fig. 1. Dorsal view; magnified 4 diameters.
„ 2. Front part of the body, seen ventrally; magnified 8 diameters.
„ 3. The mouth seen from the front; magnified 7 diameters.
„ 4. Last four joints of the ovigerous leg; magnified 41 diameters.
„ 5. Last two joints of the leg; magnified 8 diameters.

Phoxichilidium mollissimum, n. sp. (figs. 6–9).

Fig. 6. Lateral view; magnified 4 diameters.
„ 7. Mouth, front view; magnified 9 diameters.

Fig. 8. Last four joints of the ovigerous leg; magnified 28 diameters.
„ 9. Part of the sixth joint of the leg; magnified 8 diameters.

Phoxichilidium pilosum, n. sp. (figs. 10–13).

Fig. 10. Dorsal view; magnified 5 diameters.
„ 11. Front part of the body, ventral view; magnified 9 diameters.
„ 12. Last four joints of the ovigerous leg; magnified 41 diameters.
„ 13. Last two joints of the leg; magnified 9 diameters.

PLATE XIV.

Phoxichilidium fluminense, Kröyer (figs. 1–4).

Fig. 1. Ventral view; magnified 8 diameters.
„ 2. Oculiferous tubercle, dorsal view; magnified 28 diameters.
„ 3. Last five joints of the ovigerous leg; magnified 56 diameters.
„ 4. Last two joints of the leg; magnified 28 diameters.

Phoxichilidium insigne, n. sp. (figs. 5–7).

Fig. 5. Dorsal view; magnified $8\frac{1}{2}$ diameters.
„ 6. Front part of the body, seen ventrally; magnified 28 diameters.
„ 7. Last two joints of the leg; magnified 56 diameters.

Hannonia typica, n. gen., n. sp. (figs. 8–11).

Fig. 8. Dorsal view; magnified 17 diameters.
„ 9. Ventral view; magnified $5\frac{1}{2}$ diameters.
„ 10. Last four joints of the ovigerous leg; magnified 70 diameters.
„ 11. Last two joints of the leg; magnified 30 diameters.

PLATE XV.

Nymphon macronyx, G. O. Sars. (figs. 1–7).

Fig. 1. Ventral view; magnified 7 diameters.
„ 2. Oculiferous tubercle; magnified 64 diameters.
„ 3. Mandible; magnified 41 diameters.
„ 4. Palpus; magnified 41 diameters.
„ 5. Denticulate spines of the ovigerous legs; magnified 272 diameters.
„ 6. Claw of the ovigerous leg; magnified 272 diameters.
„ 7. Last two joints of the leg; magnified 41 diameters.

Nymphon longicoxa, Hoek (figs. 8, 9).

Fig. 8. Spines at the sixth joint of the ovigerous leg of a male; magnified 272 diameters.

„ 9. Genital opening of the male; magnified 136 diameters.

Nymphon compactum, Hoek (fig. 10).

Fig. 10. Last two joints of the leg; magnified 7 diameters.

Nymphon longicollum, Hoek (fig. 11).

Fig. 11. Auxiliary claws; magnified 272 diameters.

Nymphon brevicollum, Hoek (figs. 12, 13).

Fig. 12. Articulation (?) in the fifth joint of the ovigerous leg of the male; magnified 94 diameters.

„ 13. The ovigerous leg of the male; magnified 7 diameters.

Ascorhynchus orthorhynchus, Hoek (figs. 14, 15).

Fig. 14. Mouth, front view; magnified 5 diameters.

„ 15. Genital pore of the female; magnified 64 diameters.

Ascorhynchus glaber, Hoek (fig. 16).

Fig. 16. Articulation of the proboscis; magnified 6 diameters.

PLATE XVI.

Structure of the integument of *Nymphon robustum*, Bell (figs. 1–3).

Fig. 1. Transverse section of the integument; magnified 272 diameters. *a*, spine; *b*, respiratory cavity; *c*, setæ; *d*, nerve; *e*, blood-corpuscles; *f*, epithelium.

„ 2. Setæ; magnified 575 diameters.

„ 3. Setæ; magnified 575 diameters.

Structure of the integument of *Nymphonhamatum*, Hoek (figs. 4–6).

Fig. 4. Surface of the fourth joint of the leg of a male; magnified 94 diameters. *g*, pores.

„ 5. Structure of the gland; magnified 272 diameters.

„ 6. Transverse section of the thigh of a male; magnified 94 diameters. *g*, pore; *k*, blood; *i*, intestinal cœcum; *h*, gland.

Structure of the integument of *Nymphon brevicaudatum*, Miers (fig. 7).

Fig. 7. Transverse section of the fourth joint of the leg of a female; magnified 56 diameters. *i*, as in fig. 6; *l*, mature egg; *m*, immature eggs; *x*, mud.

Structure of the integument of *Ascorhynchus glaber*, Hoek (figs. 8–10).

Fig. 8. Transverse section of a part of the integument; magnified 272 diameters. *b, c, e*, as in fig. 1.

,, 9. Transverse section of the thigh of a male; magnified 56 diameters. *n*, testis; *g, h, i, k*, as in fig 6.

,, 10. Cells from the glandular mass of the male; magnified 272 diameters.

Genital organs, &c., of *Ascorhynchus orthorhynchus*, Hoek (fig. 11).

Fig. 11. Transverse section of the thigh of a female; magnified 56 diameters. *k, m, h, i*, as in figs. 6 and 7.

Structure of the integument of *Colossendeis leptorhynchus*, Hoek (figs. 12, 13).

Fig. 12. Transverse section of a part of the integument; magnified 170 diameters. *b, e*, as in fig. 1.

,, 13. Spine; magnified 170 diameters.

Structure of the integument of *Colossendeis megalonyx*, Hoek (fig. 14).

Fig. 14. Transverse section through the thigh of a male; magnified 41 diameters. *h, i*, as in fig. 6.

Structure of the integument, &c., of *Colossendeis leptorhynchus*, Hoek (figs. 15, 16).

Fig. 15. Transverse section through the thigh of a male; magnified 272 diameters. *o*, vesicle; *p*, wounded canal.

,, 16. Transverse section of the thigh of a female; magnified 56 diameters. *m, i*, as in fig. 7.

Structure of the integument of *Phoxichilidium patagonicum*, Hoek (fig. 17).

Fig. 17. Transverse section of the integument of a female; magnified 170 diameters. *b, c, f*, as in fig. 1.

Structure of the integument, &c., of *Phoxichilidium insigne*, Hoek (fig. 18).

Fig. 18. Transverse section of the thigh of a male; magnified 94 diameters. *h, i, k*, as in fig. 6.

PLATE XVII.

Fig. 1. *Colossendeis proboscidea*, Sab. (sp.); dorsal half of the body; magnified 6 diameters. *a*, intestine; a^1, a^2, two short cæca not reaching beyond the cephalothorax; *b*, muscles moving the proboscis; *c*, heart; *d*, anus.

Fig. 2. *Colossendeis proboscidea*, Sab. (sp.); ventral half of the body with the nervous system; magnified 6 diameters. *a*, parts of the intestine; *p*, palpus; I. II.–V., first to fifth thoracic ganglia; *n.p.* and *n.pr.*, two branches of the palpar nerve; *n.o.l.*, nerve for the ovigerous leg; n^1–n^4, four nerves for the legs; *n.a.*, nerves for the abdomen.

" 3. *Nymphon robustum*, Bell; ventral half with the nervous system; magnified 6 diameters. *a*, parts of the intestine, cœca, &c.; *m.u.*, muscles running from the one segment to the other; *n.p.*, palpar nerve; *n.pr.*, proboscideal nerve; *n.o.l.*, n^1–n^4, *n.a.*, as in fig. 2.

" 4. *Nymphon robustum*, Bell; supraœsophageal ganglion with its nerves; magnified 6 diameters. *a*, intestine; *m*, mandibles; *g.s.o.*, supraœsophageal ganglion; *c*, œsophageal commissures; *n.m.*, nerve for the mandibles; *u.p.n.*, unpair proboscideal nerve; *p.p.n.*, small proboscideal nerves; *g.p.*, proboscideal ganglion.

" 5. *Nymphon robustum*, Bell; dorsal half of the body showing the intestine; magnified 4 diameters. *a*, intestine; *e*, œsophagus.

" 6. *Nymphon robustum*, Bell; part of the intestine; magnified 47 diameters. *a*, intestine; *e*, œsophagus; *gl*, intestine glands.

PLATE XVIII.

Fig. 1. Integumentary cavities of *Colossendeis leptorhynchus*, Hoek; ♀ specimen; first tibial joint; magnified 287 diameters. *i*, part of the wall of the intestinal cœcum; *c*, septa of connective tissue; *b*, blood-corpuscles; *d*, and *d′*, glandular cells.

" 2. Transverse section of the fourth joint of the leg of *Colossendeis proboscidea*, Sab. (sp.); ♂ specimen; magnified 47 diameters. *i*, intestinal cœcum; *g*, glands; *t*, testis; *c*, fibres of connective tissue.

" 3. Part of the integument of *Colossendeis proboscidea*, Sab. (sp.); fourth joint of the leg; ♂ specimen; magnified 272 diameters. *c*, integumentary cavity; *g*, gland; *d*, duct of the gland.

" 4. Œsophageal ring of *Colossendeis megalonyx*, Hoek; magnified 40 diameters. *s.* supraœsophageal ganglion; *c*, commissures; *t*, first thoracic ganglion; *pr.* azygous proboscideal nerve; *m*, mandibular nerve; *o*, optic nerves (?); *t′*, first nerve arising from the first thoracic ganglion; *t″*, second nerve (one of the three main proboscideal nerves), dividing into two branches after penetrating the proboscis; *pa.*, palpar nerve (dividing in two branches close to the ganglion); *o*, nerve for the ovigerous leg; *c′*, commissures between the first and second thoracic ganglia.

Fig. 5. Innervation of the rudimentary eyes of *Nymphon robustum*, Bell; magnified 94 diameters. *n*, optic nerves forming the ganglion *g*; *t*, oculiferous tubercle; *o*, rudimentary eyes.

,, 6. Innervation of the proboscis of *Nymphon robustum*, Bell; magnified 10 diameters. The proboscis has been figured as transparent; the mandible and the palp of the left side have been cut away. *t*, oculiferous tubercle; *s*, supraœsophagal ganglion; *c*, œsophagal commissures; *u*, azygous proboscideal nerve; *p*, secondary proboscideal nerves arising from the supraœsophageal ganglion; *mn*, mandibular nerves; *p*, proboscideal nerves arising from the first thoracic ganglion; *g*, ganglionic bundles; *x*, small ganglia in the front of the proboscis; *y*, large proboscideal ganglia; *a*, first proboscideal nerve ring; a^{I}–a^{IV} second to fifth proboscideal ring.

,, 7. Transverse section of cephalothoracic segment of *Colossendeis leptorhynchus*, Hoek (female specimen); magnified 10 diameters. *s*, supraœsophageal ganglion; *t*, first thoracic ganglion; *œ*, œsophagus; *c*, œsophageal commissures; *i*, rudimentary cœca of the intestine; *m*, and *m′*, muscle-bundles; *m*, passing through the œsophageal commissures.

,, 8. Part of the ganglionic bundle in the proboscis of *Nymphon robustum*, Bell; magnified 94 diameters. *u*, *g*, *a*, *a′*, *a″*, *x*, and *y*, as in fig. 6.

,, 9. Transverse section of the proboscis of *Nymphon robustum*, Bell; magnified 23 diameters. I., II., and III. the three chitinous plates limiting the œsophageal cavity; *t*, transverse muscles; *l*, longitudinal muscle-bundles; *a*, proboscideal ring; *g*, ganglion of the ganglionic bundle; *p*, the three main proboscideal nerves on transverse section.

,, 10. One of the ganglia on the inner surface of the integument of *Colossendeis proboscidea*, Sab. (sp.); magnified 272 diameters. *c*, integumentary cavities; *b*, blood-corpuscles.

,, 11. Six sections through the supraœsophageal and first thoracic ganglia of *Nymphon strömii*, Kröyer; magnified 56 diameters. *s*, supraœsophageal ganglion; *œ*, œsophagus; *t*, first thoracic ganglion; *i*, intestinal cœcum for the mandibles; *c*, fibres of connective tissue; *o*, optic lobes; *o′*, part of the optic nerves; *m*, mandibular lobes; *x*, azygous lobe of unknown function; *co*, œsophageal commissures; *p*, origin of the two main proboscideal nerves; *l*, origin of the nerves for the ovigerous legs; *co′*, commissures between the first and second thoracic ganglia.

,, 12. Longitudinal section through the first thoracic ganglia of *Nymphon brachyrhynchus*, Hoek; magnified 170 diameters. *pr*, proboscideal nerves; *pa*, part of the neurilemma of the palpar nerve; *e*, part of the neurilemma of the ovigerous nerve; *c*, commissure between this and the second thoracic ganglion.

PLATE XIX.

Fig. 1. Egg-mass of *Nymphon brevicollum*, Hoek; magnified 16 diameters.
,, 2. Transverse section of egg-mass of *Nymphon brevicollum*, Hoek; magnified 41 diameters. *o*, opening occupied by the ovigerous leg; *s*, small pores left between the eggs; *c*, the substance soldering the eggs together; *m*, mud.
,, 3. Transverse section of the egg of *Nymphon brevicollum*, Hoek; magnified 272 diameters.
,, 4. Structure of the protoplasm of one of the segments of the same egg; magnified 575 diameters.
,, 5. Cells of the blastoderm and segments of the nutritive yolk of *Nymphon brevicaudatum*, Miers; magnified 272 diameters.
,, 6. Nuclei of the cells of the blastoderm of the egg of *Nymphon brevicaudatum*, Miers; magnified 575 diameters.
,, 7. Transverse section through the egg of *Nymphon brevicaudatum*, Miers; magnified 94 diameters.
,, 8. Embryo of *Nymphon brachyrhynchus*, Hoek, showing the three pairs of appendages and the proboscis; magnified 94 diameters.
,, 9. Front part of the embryo of *Nymphon brevicaudatum*, Miers, seen ventrally; magnified 135 diameters.
,, 10. The embryo of *Nymphon brevicaudatum*, Miers, ventral view; magnified 94 diameters.
,, 11. Transverse section through the egg of *Nymphon brevicaudatum*, Miers; magnified 94 diameters. *a*, mandible; *b*, first pair of legs; *c*, *d*, second and third pair of cephalic appendages.
,, 12. Larva of *Nymphon brevicollum*, Hoek, dorsal view; magnified 94 diameters.
,, 13. Larva of *Nymphon brevicollum*, Hoek, ventral view; magnified 94 diameters.

PLATE XX.

Fig. 1. Larva of *Nymphon brevicollum*, Hoek; magnified 94 diameters.
,, 2. Spinning apparatus in the mandible of the larva of *Nymphon brevicollum*, Hoek; magnified 94 diameters.
,, 3. Front part of the larva of *Nymphon hamatum*, Hoek; magnified 94 diameters.
,, 4. Spinning apparatus in the mandible of the larva of *Nymphon hamatum*, Hoek; magnified 272 diameters.
,, 5. Spinning apparatus in the mandible of *Nymphon longicoxa*, Hoek; magnified 272 diameters.
,, 6. Larva of *Ascorhynchus minutus*, Hoek; magnified 272 diameters.

PLATE XXI.

Fig. 1. Eye of *Nymphon strömii*, Kröyer, transverse section; magnified 272 diameters.

" 2. Eye of *Nymphon brachyrhynchus*, Hoek, longitudinal section, taken laterally; magnified 170 diameters.

" 3. Eye of *Nymphon brachyrhynchus*, Hoek, longitudinal section, passing nearly through the middle; magnified 170 diameters.

" 4. Rods and ganglion cells from the eye of *Nymphon brachyrhynchus*, Hoek; magnified 575 diameters.

" 5. Rods (isolated) from the eye of *Nymphon brachyrhynchus*, Hoek; magnified 575 diameters.

" 6. Œsophagus of *Nymphon hamatum*, Hoek, transverse section; magnified 272 diameters.

" 7. Glands at the end of the œsophagus of *Nymphon hamatum*, Hoek; magnified 94 diameters. *a*, the glands; *s*, supraœsophageal ganglion; *f*, first thoracic ganglion.

" 8. Glands at the end of the œsophagus of *Nymphon hamatum*, Hoek, transverse section; magnified 170 diameters. *a*, the glands; *b*, the wall of the intestine.

" 9. Group of fat cells from *Nymphon robustum*, Bell; magnified 272 diameters.

" 10. Male genital organs of *Colossendeis proboscidea*, Sab. (sp.), natural size. *a*, testis; *b*, intestine.

" 11. The opening of the male genital organs in the second joint of the leg of *Colossendeis proboscidea*, Sab. (sp.). *a*, testis; *b*, intestine; *c*, vas efferens.

" 12. Transverse section of the testis of *Colossendeis proboscidea*, Sab. (sp.); magnified 94 diameters.

" 13. Histological structure of the wall of the vas efferens of *Colossendeis proboscidea*, Sab. (sp.); magnified 575 diameters.

" 14. Transverse section of the body of *Colossendeis leptorhynchus*, Hoek, about between the second and third leg; magnified 20 diameters. *h*, heart; i^1–i^3, intestine; *o*, ovary; *n*, nervous system.

" 15. Ovarian egg of *Nymphon brevicaudatum*, Miers; magnified 94 diameters.

" 16. Section of the ovary in the fourth joint of the leg of *Nymphon robustum*, Bell; magnified 94 diameters. *i*, wall of the intestinal cœcum; *c*, cavity completely filled with eggs, when the animal is mature.

" 17. Egg of *Nymphon longicoxa*, Hoek; magnified 94 diameters.

" 18. Section through the fourth joint of the leg of *Phoxichilidium patagonicum*, Hoek; magnified 41 diameters.

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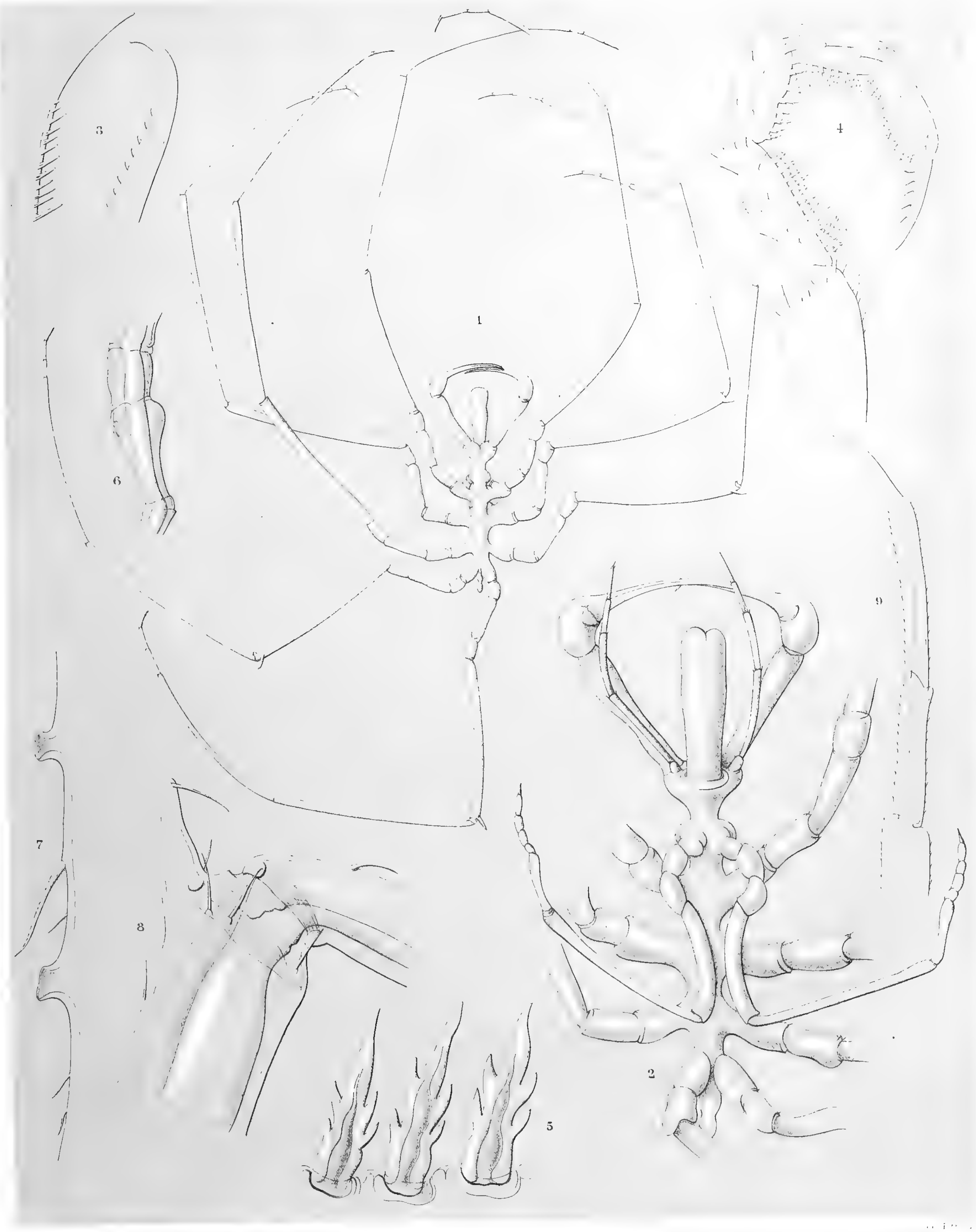

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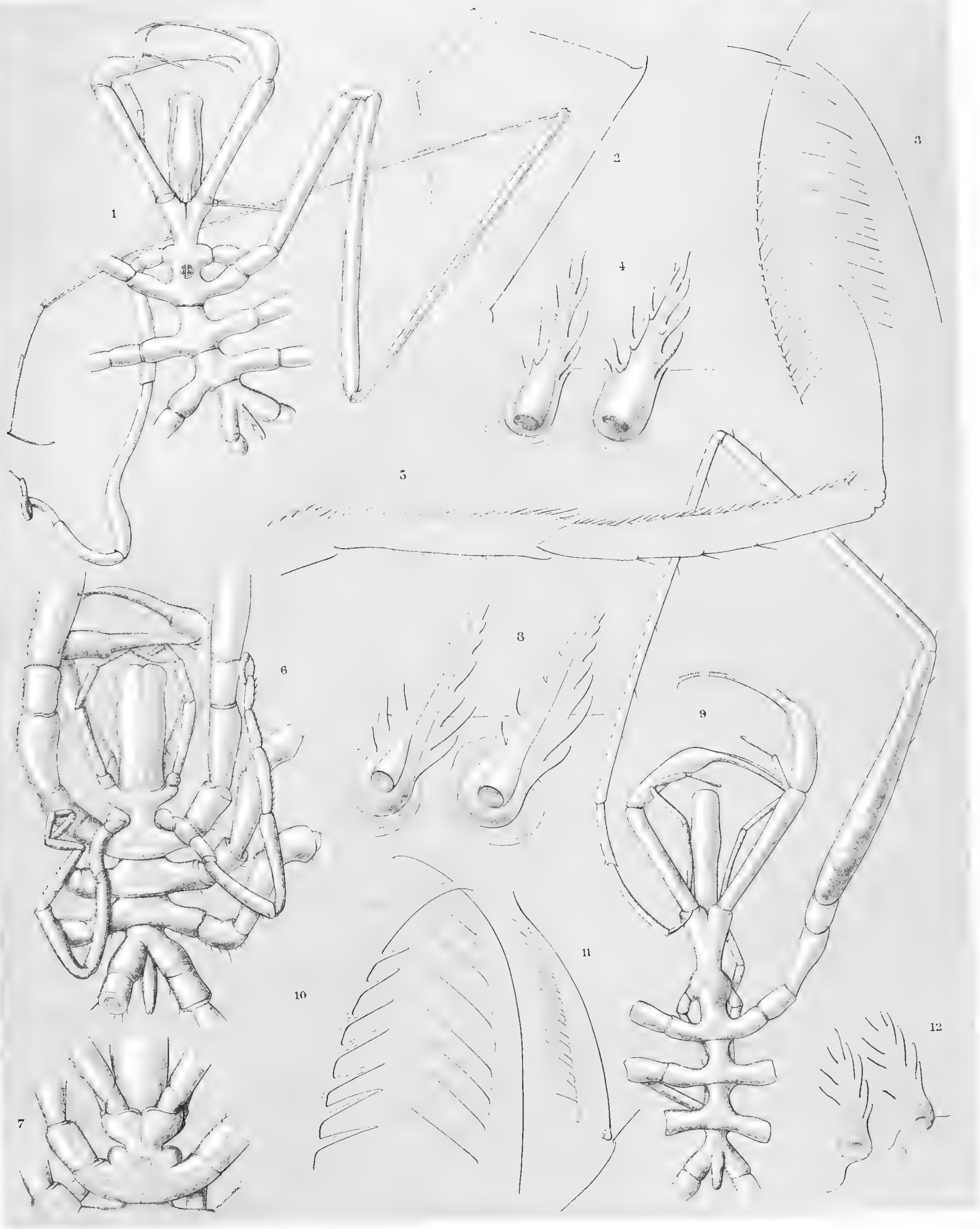

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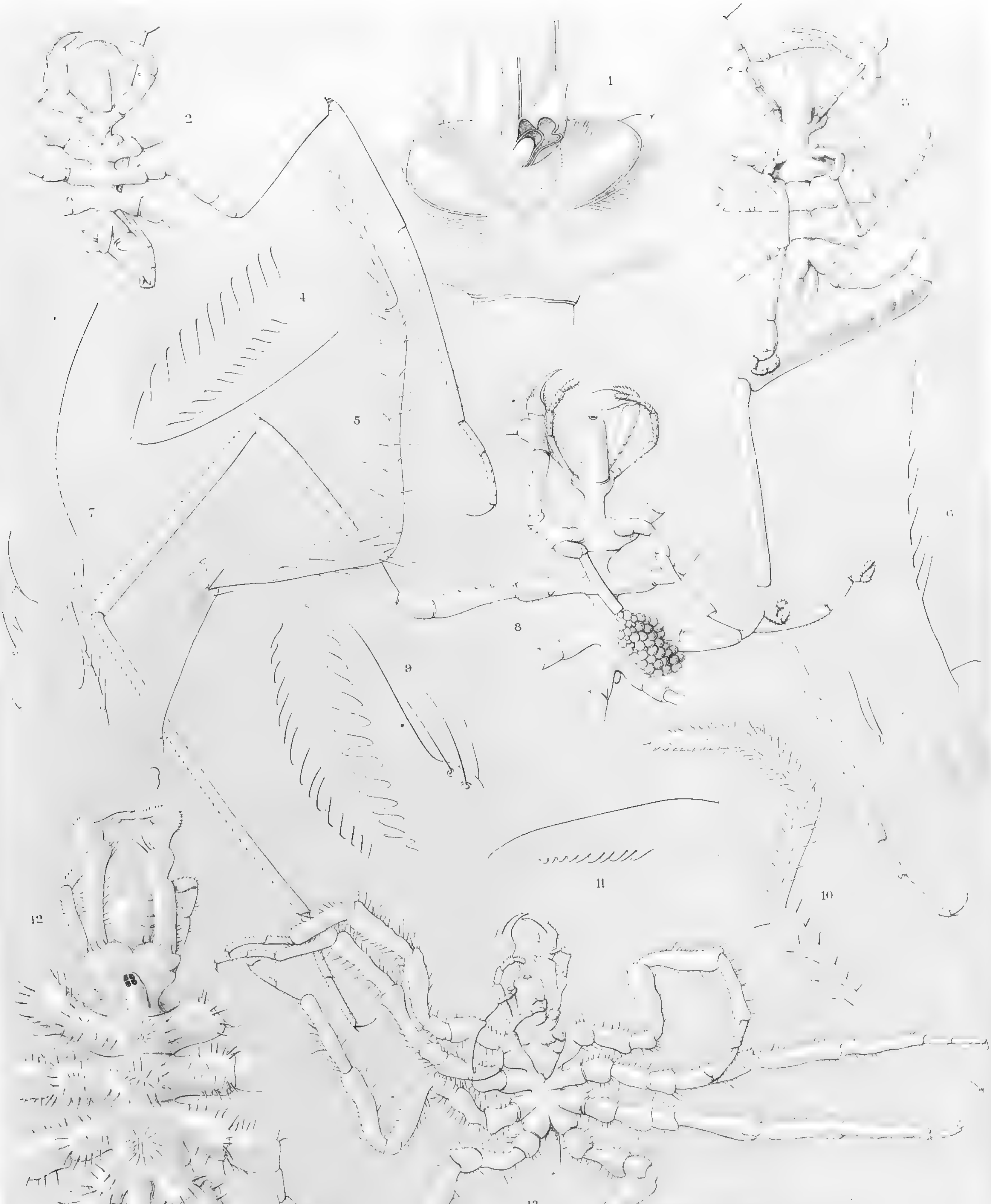

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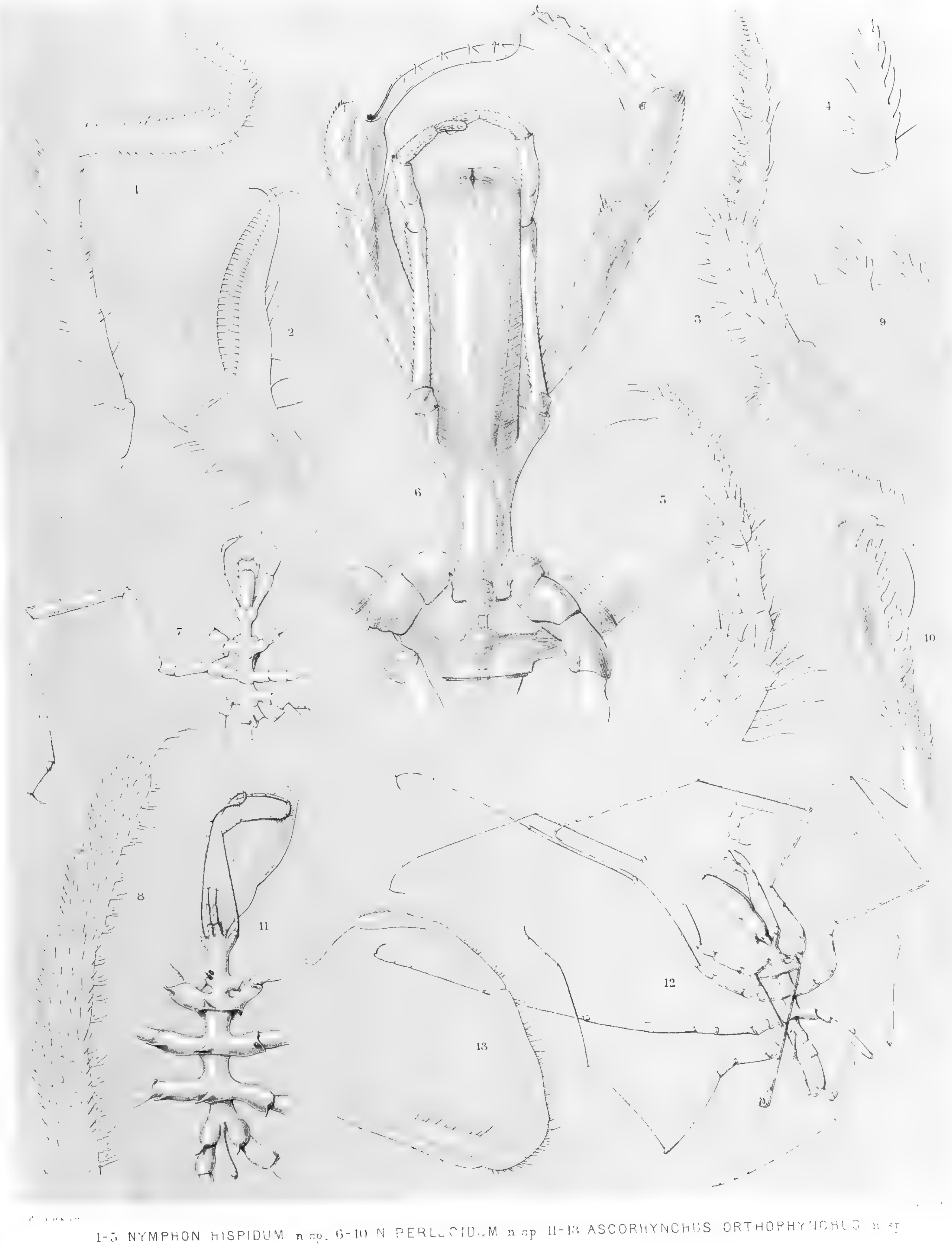

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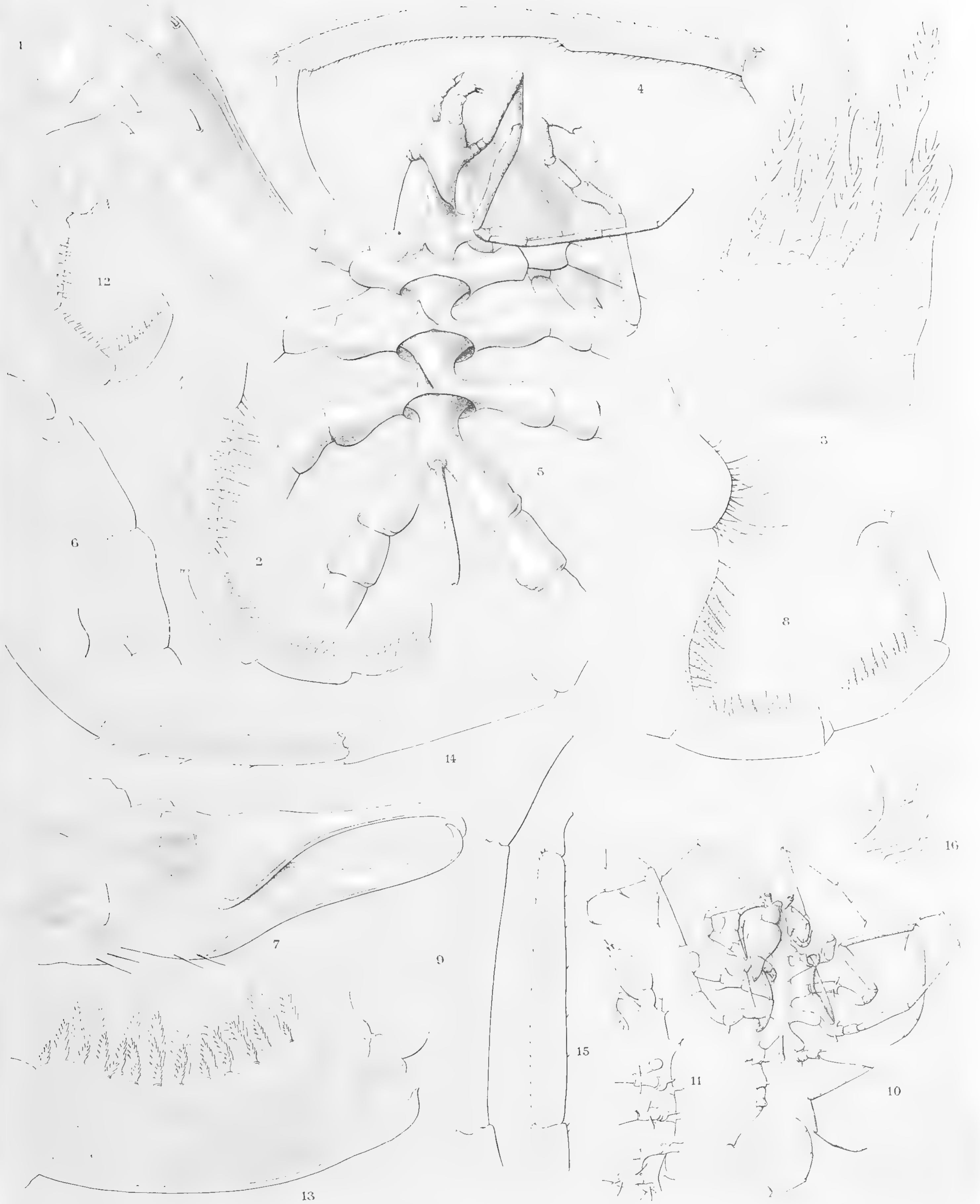

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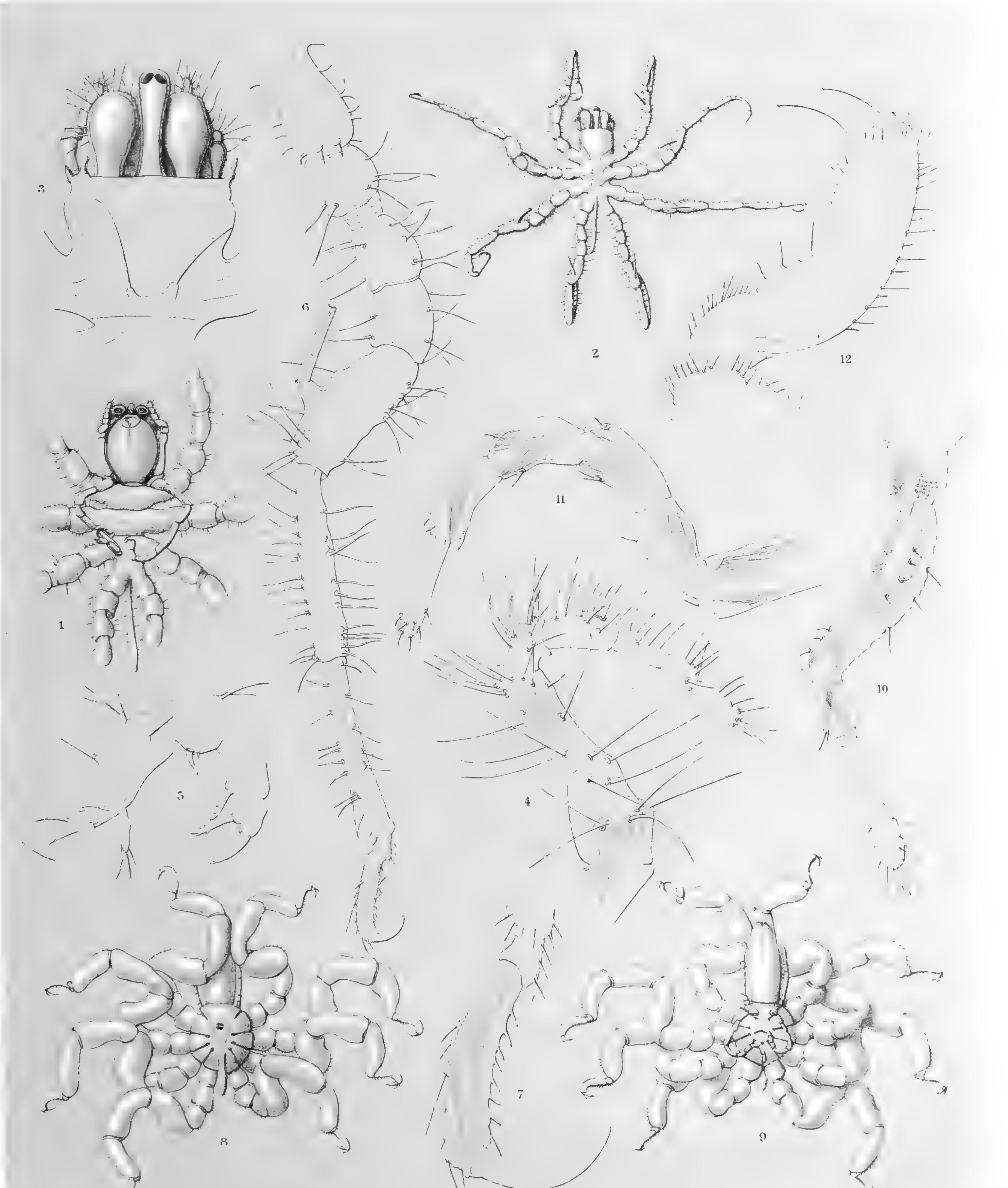

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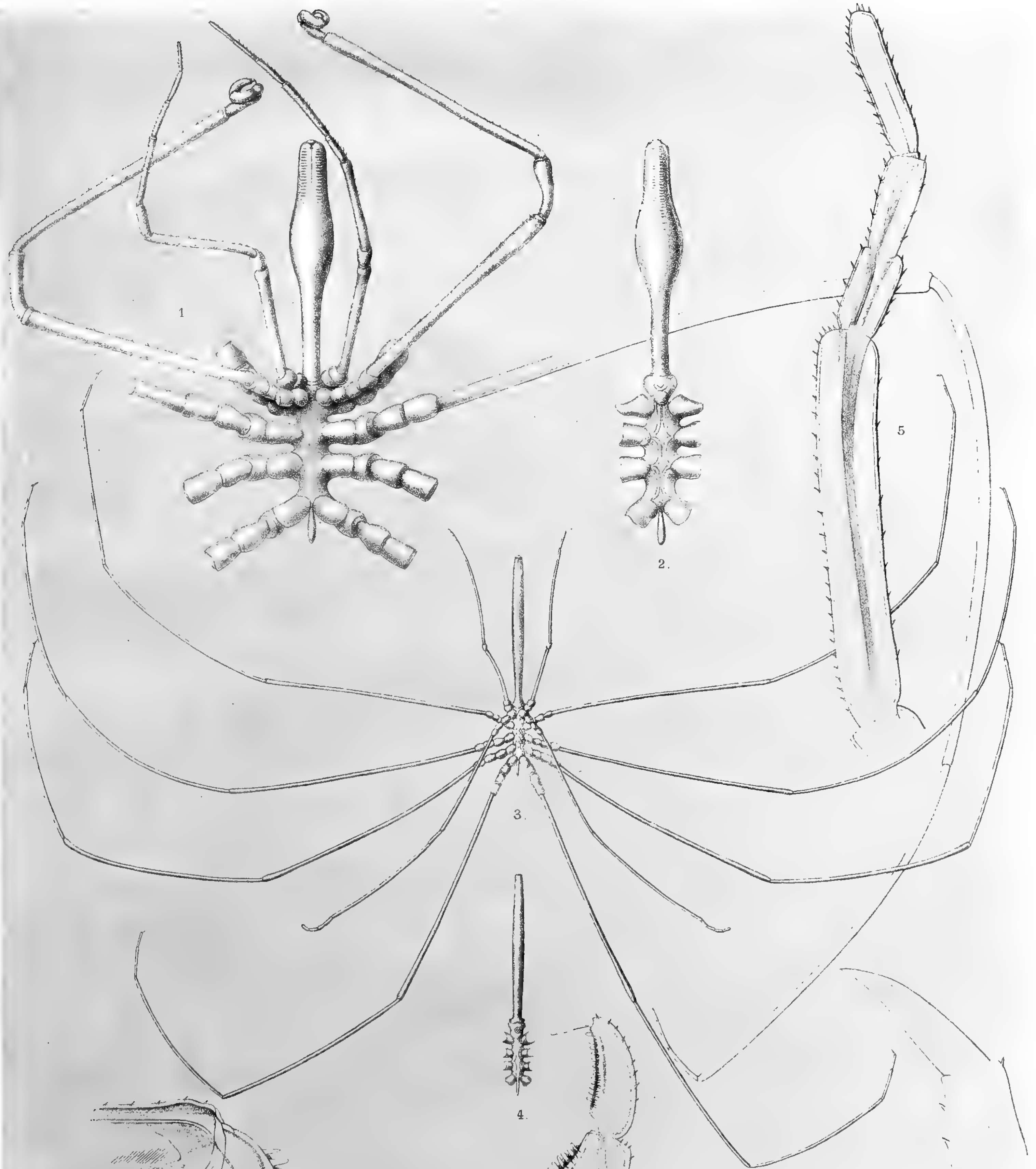

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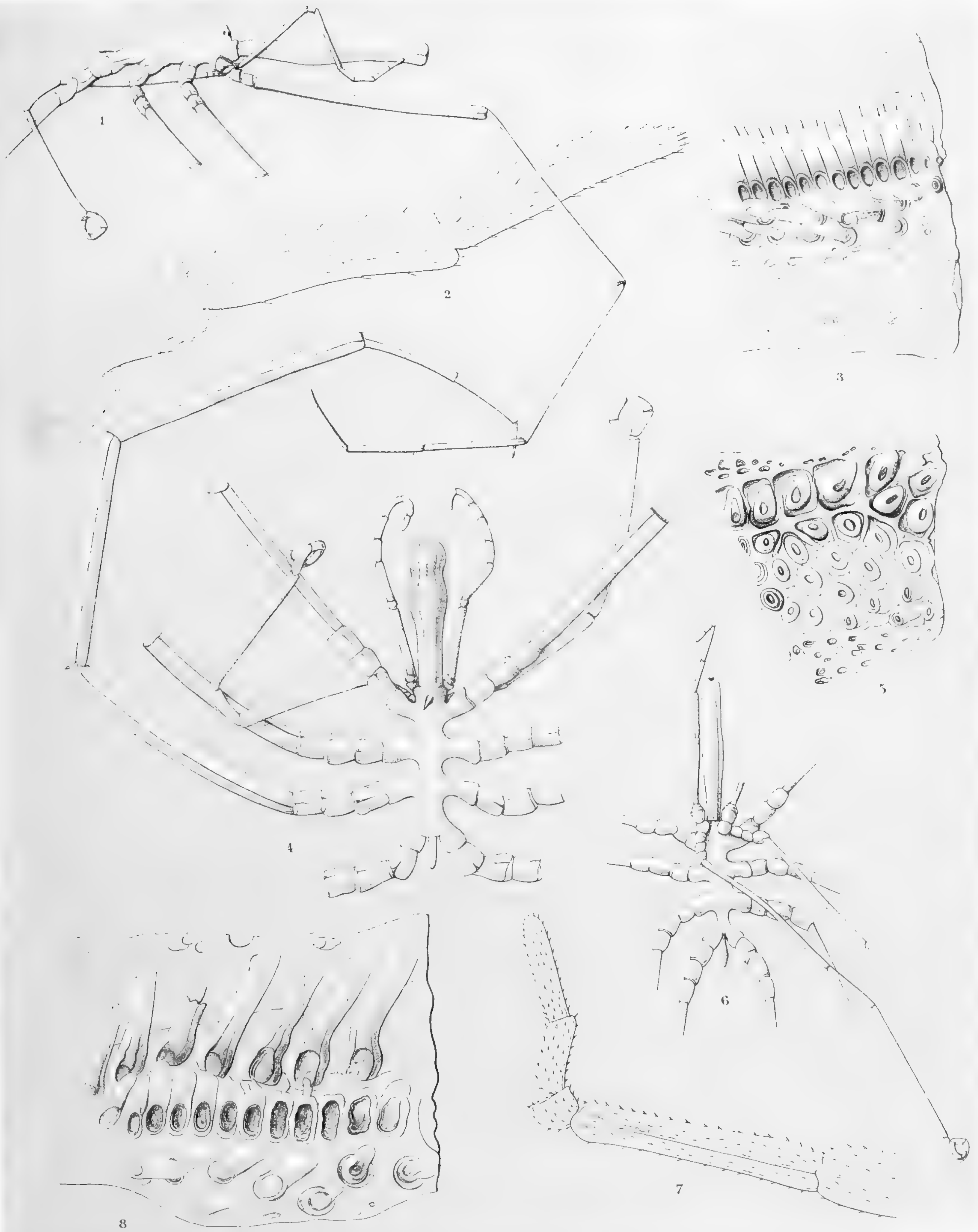

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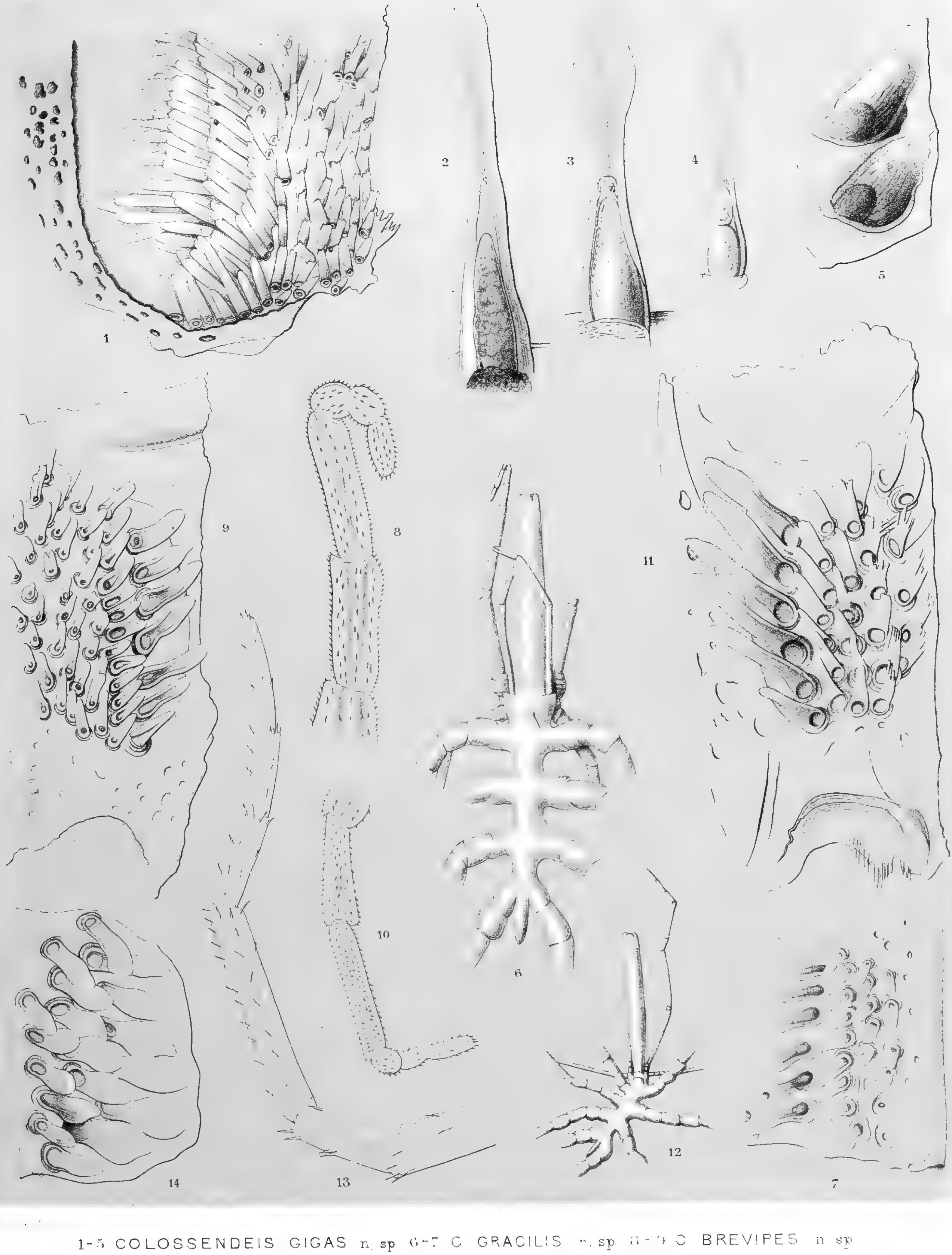

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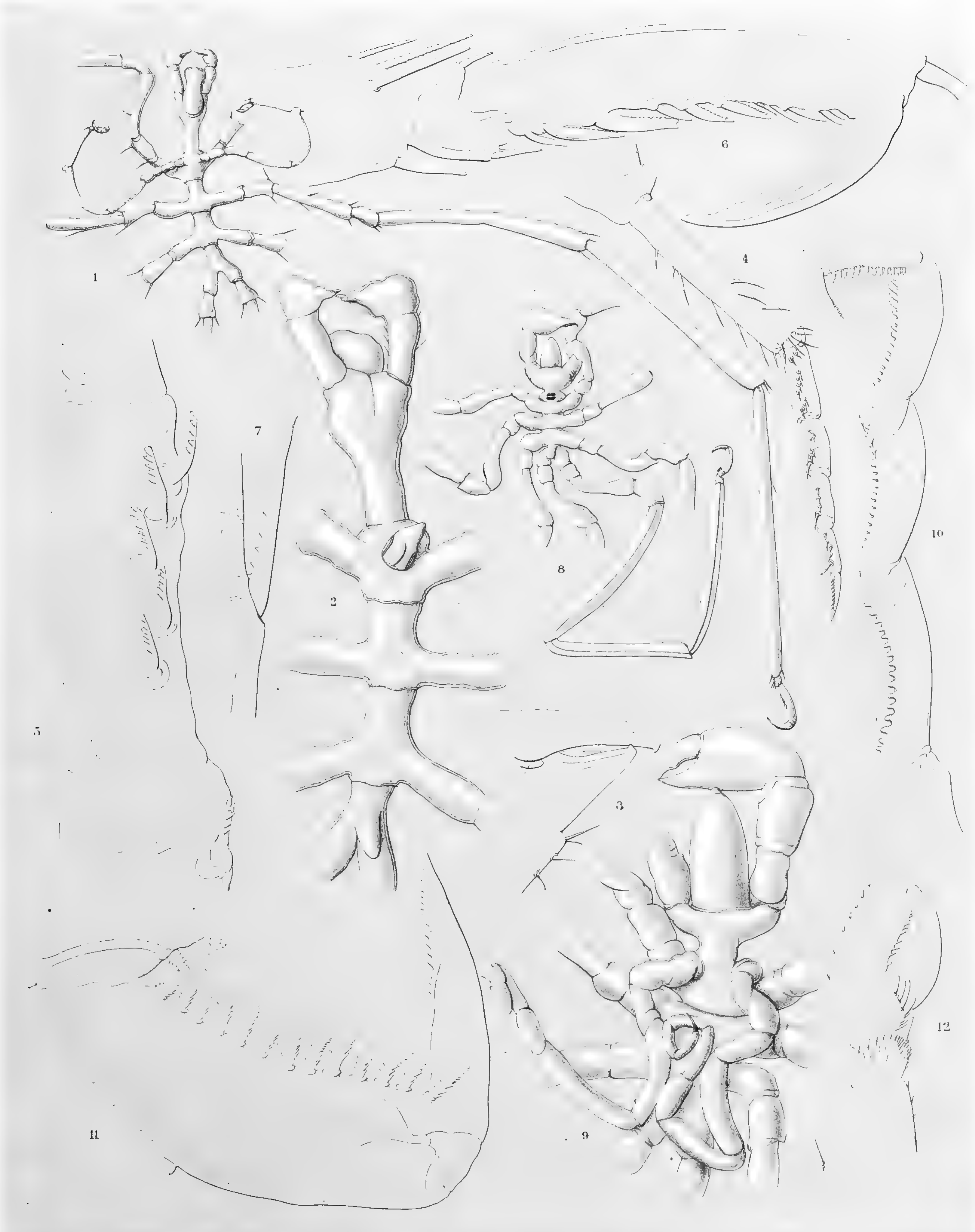

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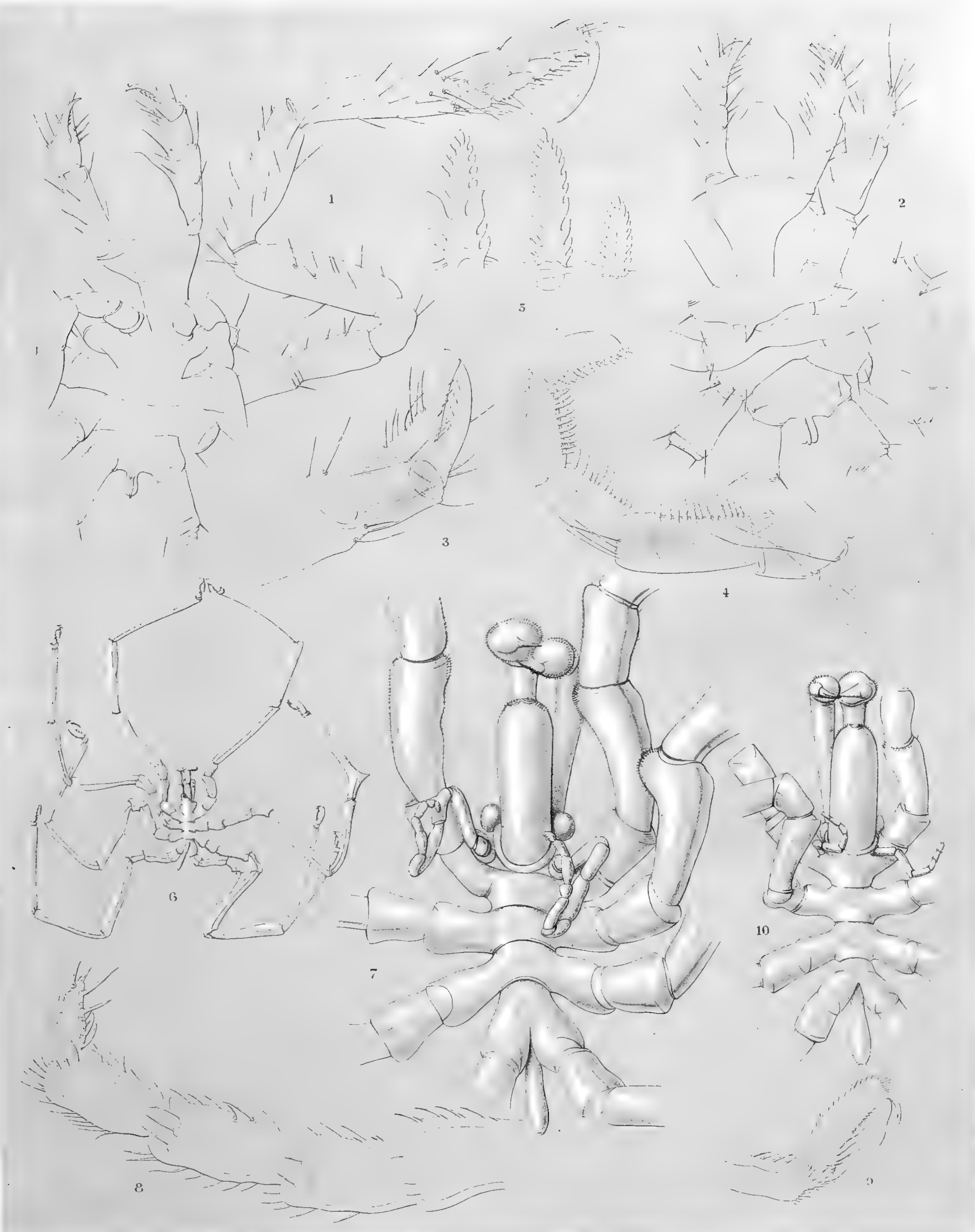

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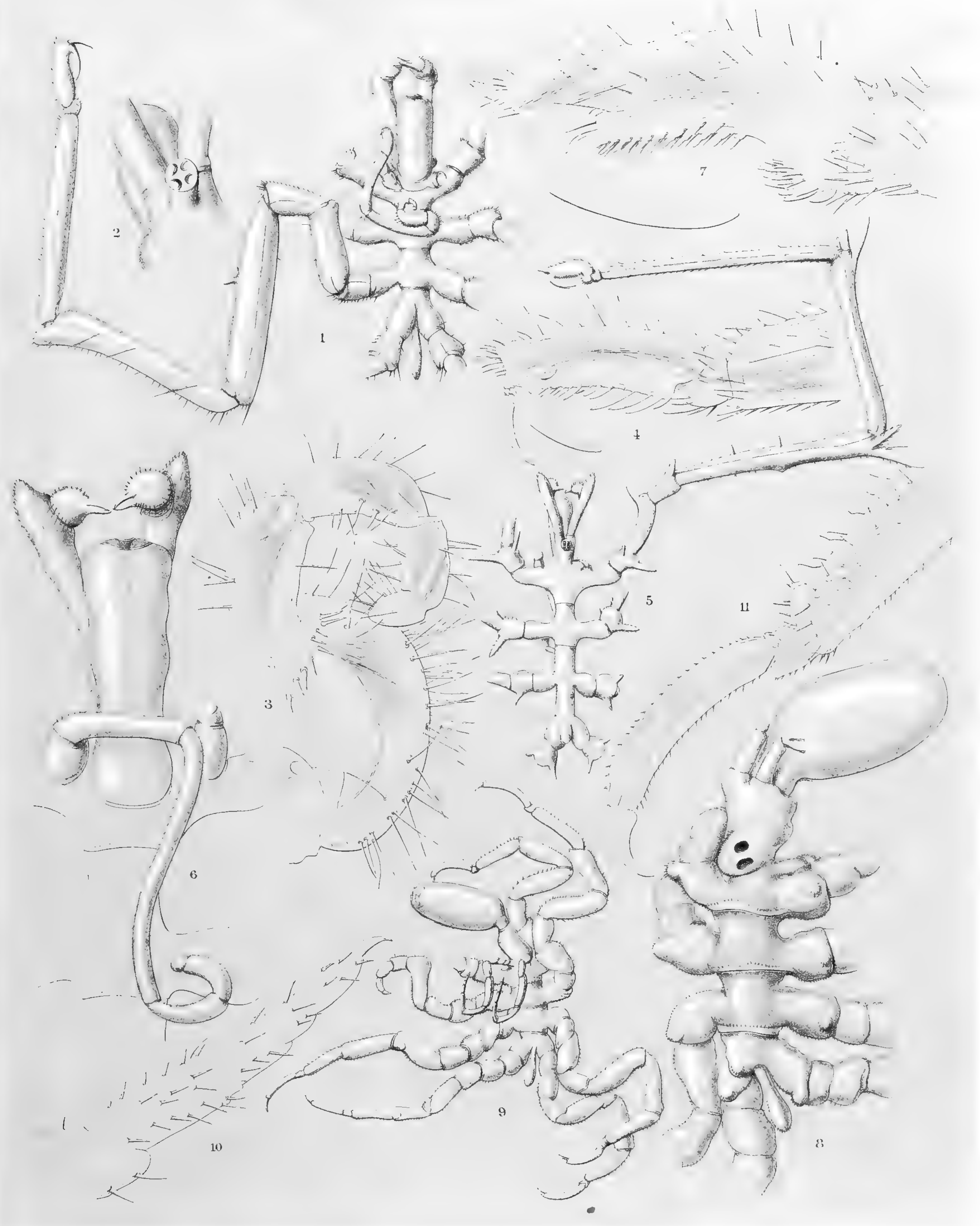

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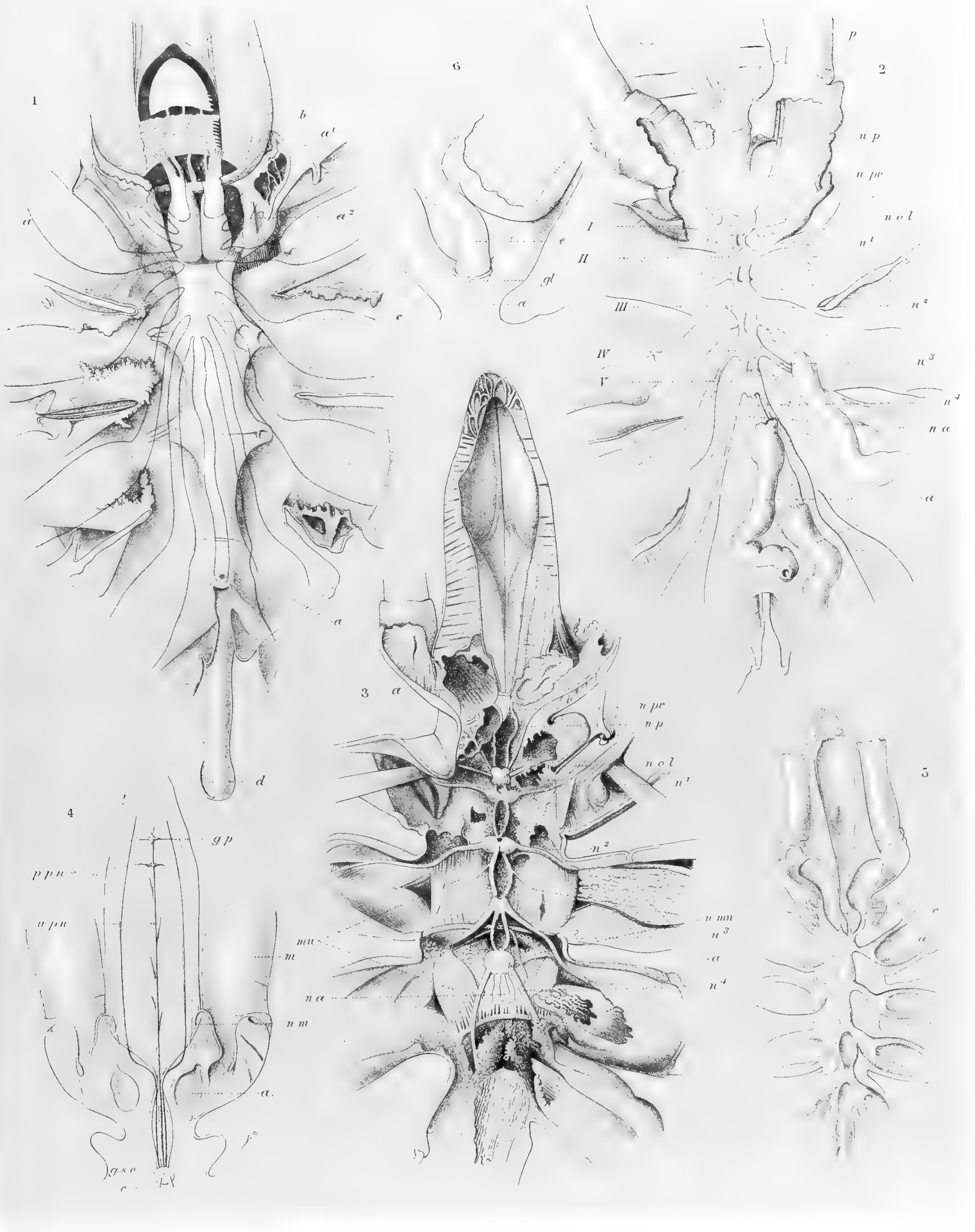

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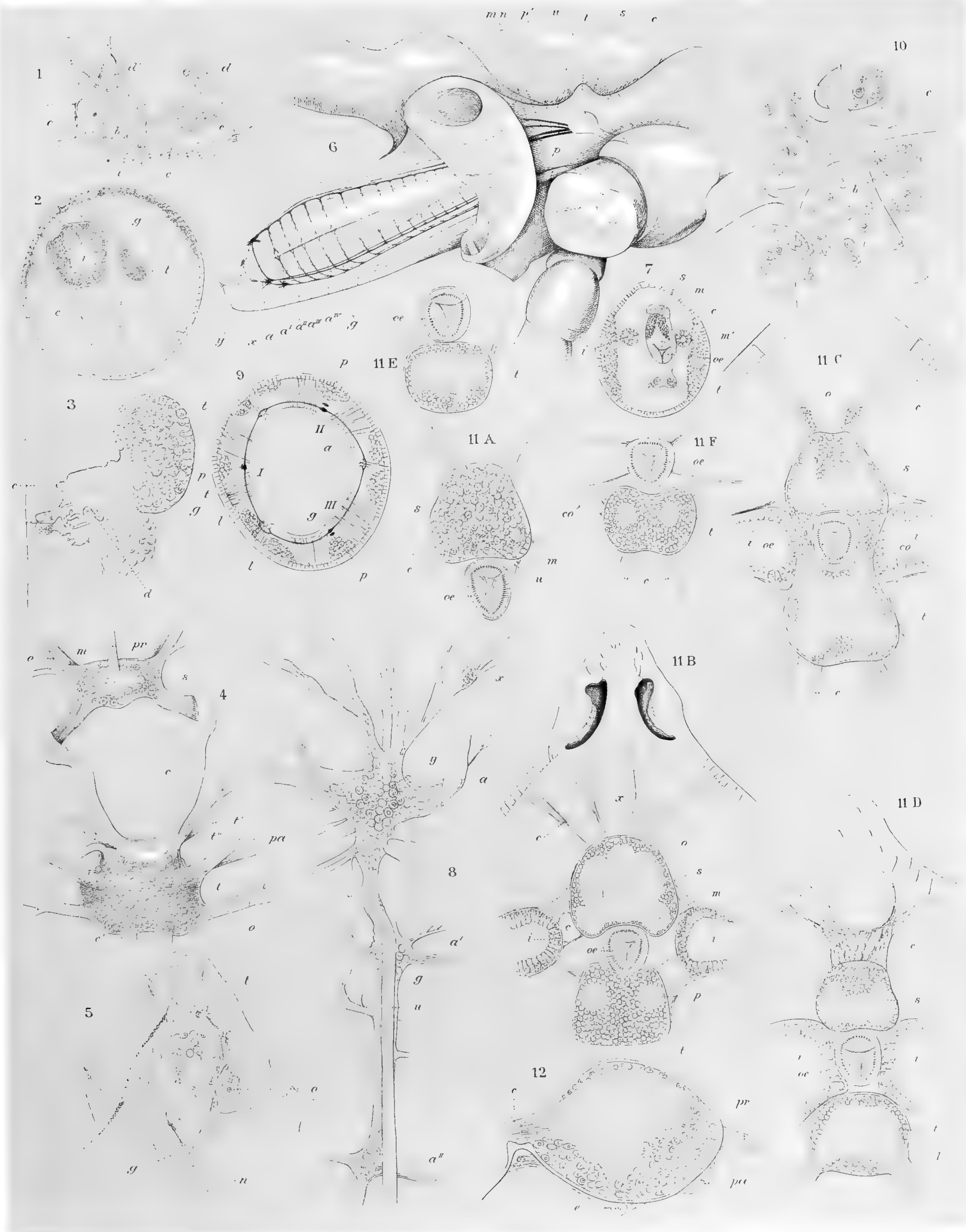

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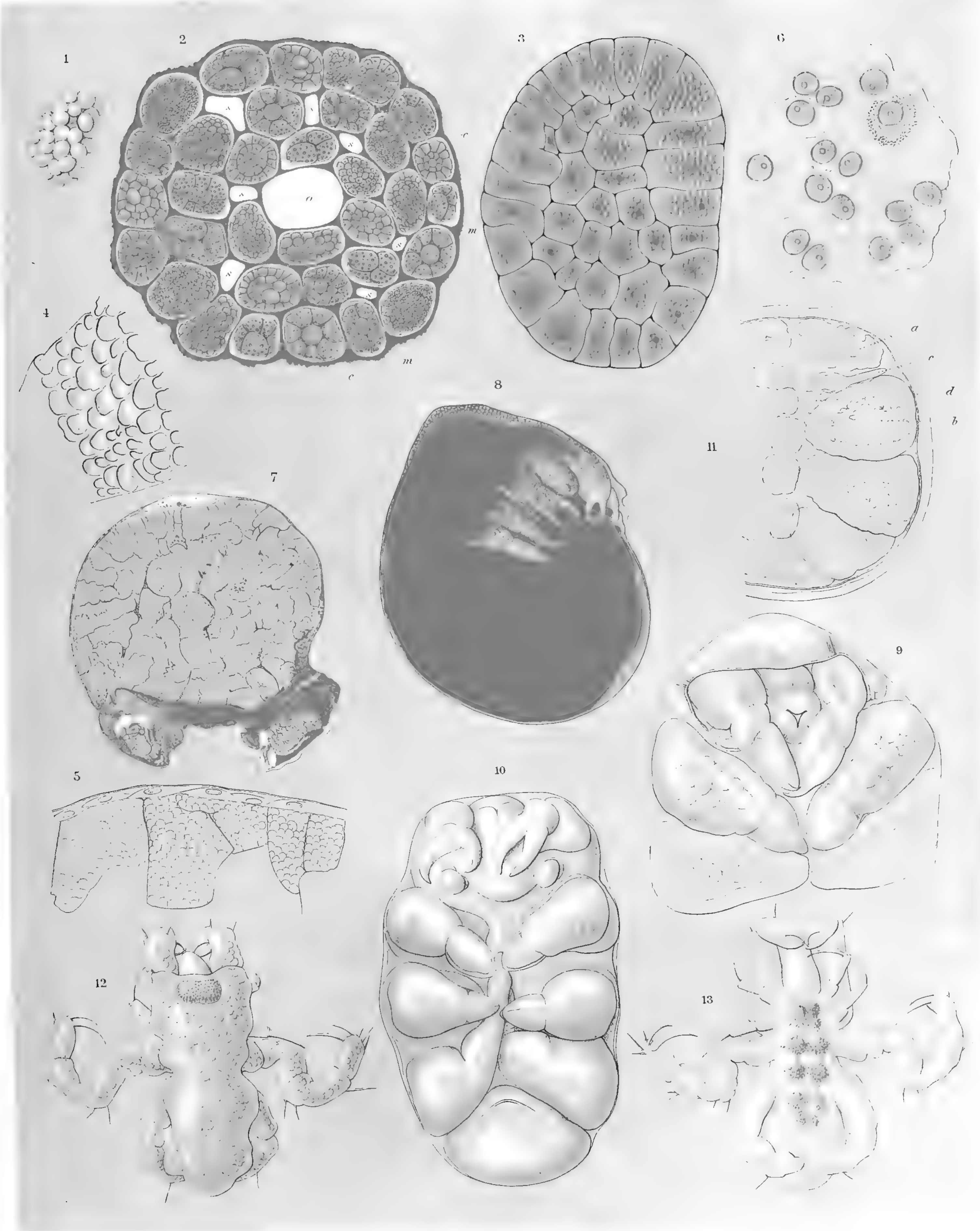
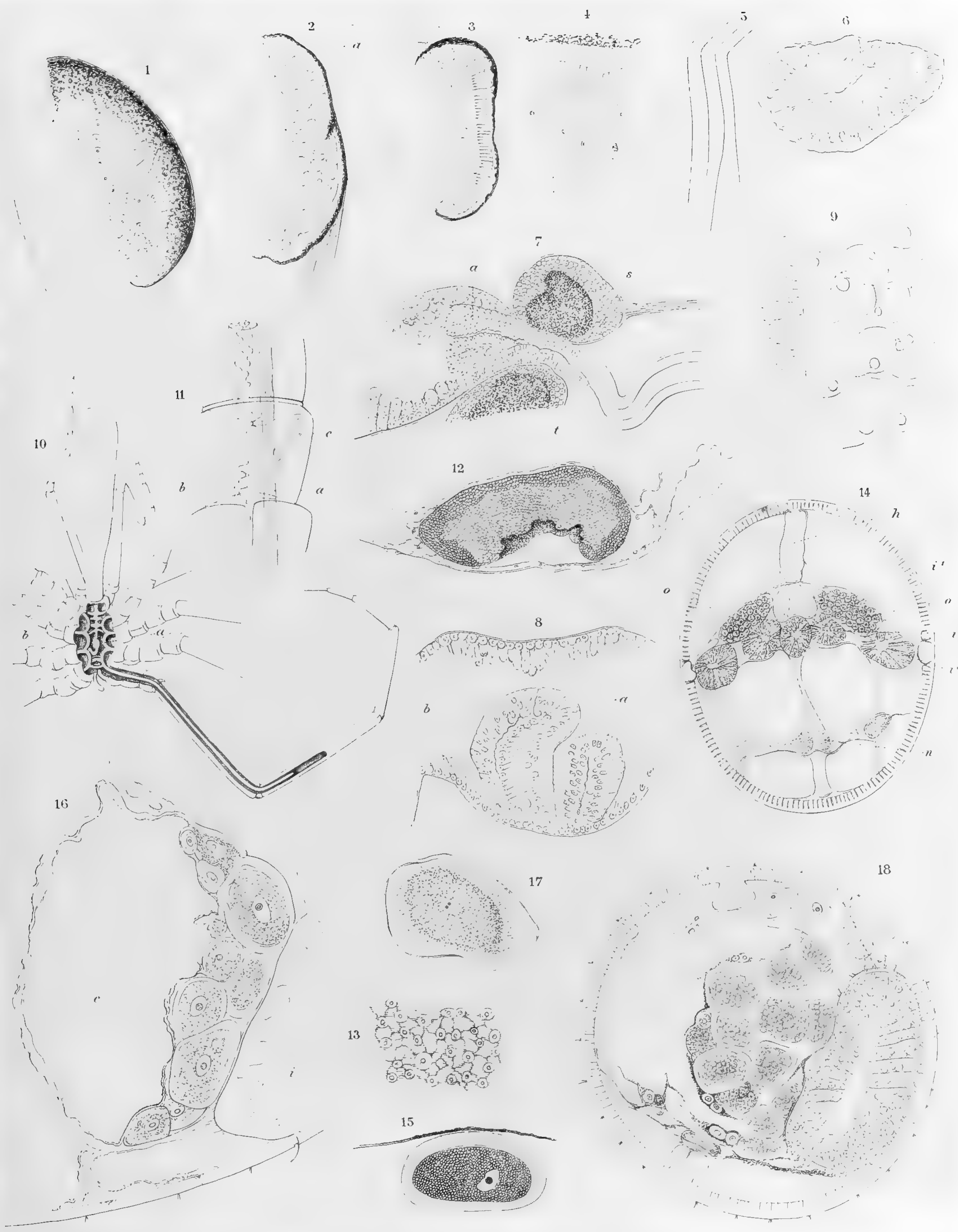


EMBRYOLOGY OF NYMPHON

EMBRYOLOGY OF NYMPHON AND ASCORHYNCHUS.



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